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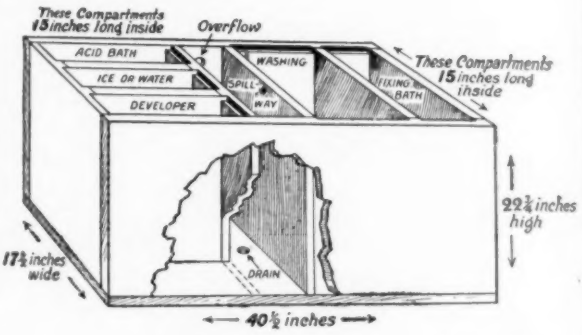

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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ROENTGEN-RAY STUDY OF NON-LUETIC PERIOSTEAL BONE LESIONS

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THE periosteum is a tough fibrous membrane adherent to the surface of the bone except at its extremities, where it is covered with cartilage. Normally the periosteum does not cast a shadow on the roentgenogram. It becomes apparent only when calcium salts have been deposited in it.

Periosteal bone production is not a clinical entity within itself, but a manifestation of the reaction of the periosteum to some irritant acting as a stimulus to bone production. The new bone is laid down in the same manner in the majority of the cases, without regard to the stimulus causing the deposition of lime salts in the periosteum, and for this reason it may often be impossible to differentiate the various conditions bringing about a periosteal reaction.

Roentgen-ray evidence of non-luetic periostitis and the formation of new subperiosteal bone is seen in a great number of bone affections. Among these may be mentioned: fractures; trauma without fractures; osteomyelitis; tuberculosis; typhoid; leprosy; pulmonary osteoarthropathy; osteitis deformans; rickets; scurvy; and the proliferative type of bone tumors.

Proliferative Lesions Due to Fractures. In fractures the fragments may be displaced and the periosteum stripped up or torn away from the shaft. The periosteum as a result of this trauma may receive a gradual deposit of mineral salts and cast a shadow on the roentgenogram in from one to four weeks, depending on the age and the condition of the patient. Such a condition is by no means common, but may occasionally be seen extending over a considerable portion of the bone.

Callus is formed in the same manner, and in addition includes the new bone thrown out around the ends of the fragments.

It seems reasonable that a trauma may initiate an irritant stimulus, causing the deposition of lime salts in the periosteum, resulting in a true traumatic periostitis. Much stress is laid on the occurrence of traumatic periostitis in the earlier literature. But MacCallum,[1] in his text-book on pathology, does not mention such a condition. Bloodgood[2] states: "I have been surprised at the infrequency of periosteal bone formation after trauma. In a large number of cases I have made *x*-ray studies after trauma and at intervals until all symptoms had disappeared with negative findings." Albee[3] describes simple inflammatory periostitis, which he states is usually traumatic in origin: "In acute cases of this lesion the *x*-ray shows no changes in the outline of the affected bone, even though considerable swelling is present clinically. In subacute and chronic cases, a faint shadow appears along the shaft, due to the deposit of lime salts in the thickened periosteum."

Local injury may permit the access and favor the production of pyogenic microorganisms, by producing tissue damage. Such a condition may give rise to an osteomyelitic process. But after reviewing a large number of radiograms, and the histories of patients showing *x*-ray evidence of periostitis, even though the onset of the illness in many cases dated from a trauma, we are unable to find a case of traumatic periostitis, without evidence of secondary infection.

FIG. 1. Fractures of the lower end of the femur of six to eight weeks' standing, showing rather extensive periosteal changes; line of fracture is visible, and alignment is good.

Periosteal Changes Due to Osteomyelitis. Osteomyelitis may occur spontaneously, and it is often accompanied by a periostitis, due in the majority of cases to staphylococcus aureus and albus. The streptococcus may also give rise to osteomyelitis. Trauma is a common predisposing cause. Injury may produce an area of lowered resistance and favor the entrance of microorganisms directly by means of a wound through the blood stream, or from a focus of suppuration in the skin, the subcutaneous or the deeper tissues. Perhaps at least one half of the cases will give a history of injury. This type is most often seen in the young. Growing tissue is more easily affected by microorganisms than is mature tissue, and osteomyelitis usually begins in the region of the epiphyseal line, where new bone is being formed. Similiar conditions may occasionally be met with as complications of certain diseases such as variola, measles, whooping-cough, pneumonia, influenza, typhoid relapsing fever, scarlatina, etc.

Osteomyelitis may involve any bone, but the most frequent sites are the femur and the tibia. The disease usually begins in the medullary canal or beneath the periosteum. When the infectious process is carried through the blood stream, it generally begins in the medullary canal. When the infection is set up as the result of a trauma, the disease usually starts in the cortex of the bone. During the very early stages of the disease, the infectious process may be confined to the medullary and

FIG. 2. Osteomyelitis following whooping-cough and pneumonia. The periosteum is raised and shows evidence of proliferation on either side of the bone, with little evidence of bone destruction.

Haversian canals without causing any variation from the normal in the radiographic appearance of the affected bone. After ten to fourteen days, areas of rarefaction are seen on the *x*-ray plate and may be accompanied by more or less extensive periosteal proliferation, depending upon the extent of the diseased process, since the periosteal reaction is the direct result of the irritation beneath it. The shaft, which may include a large part of the bone involved. The original bone is often thickened and irregular, due to the deposit of successive layers of periosteal bone on the cortex, often causing the medullary canal to appear narrowed. The cortical bone may show small areas of destruction, as illustrated by irregular

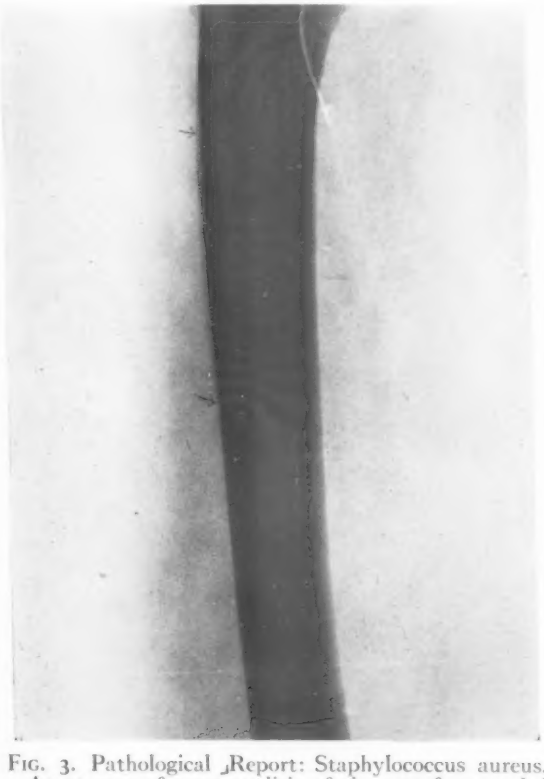

FIG. 3. Pathological Report: Staphylococcus aureus. Acute case of osteomyelitis of three to four weeks' duration. Note periostitis in lower third of femur.

FIG. 4. Chronic osteomyelitis. Extensive periosteal involvement of the lower end of the femur, nearly to the middle of the shaft.

areas of destruction coming in contact with the living bone cause the normal bone to become inflamed and ulcerated about the margins of the dead bone, helping in the formation of sequestra.

When the infectious process starts beneath the periosteum, the infection spreads more easily into the periosteum, and the cortex becomes involved more slowly, due to its density. This type is characterized by marked periosteal proliferation, accompanied by very small areas of destruction.

In chronic osteomyelitis the *x*-ray shows a pathological process confined to the patches of decreased density due to the small areas of infection remaining.

Periosteal Changes Observed in Tuberculosis. In this country tuberculosis of the shaft of the long bones has been considered a very rare condition. Radiographically the condition appears as irregular, slight or extensive areas of destruction in the cancellous bone or the medullary canal. The periosteum is involved only as the result of secondary infection. For this reason, tuberculous lesions producing periosteal reactions are generally indistinguishable from osteomyelitis of pyogenic origin.

In children the short bones of the hands and feet are prone to tuberculosis. The condition appears on the roentgenogram as irregular punched-out areas in the medulla and cortex. The diseased phalanx is increased in size and may be accompanied by a periostitis. Frequently the enlarged phalanx is accompanied by a rearrangement of the bone structure. Syphilitic dactylitis seldom shows areas of destruction. The increased size of the phalanx is the result of the elevation and thickening of the periosteum.

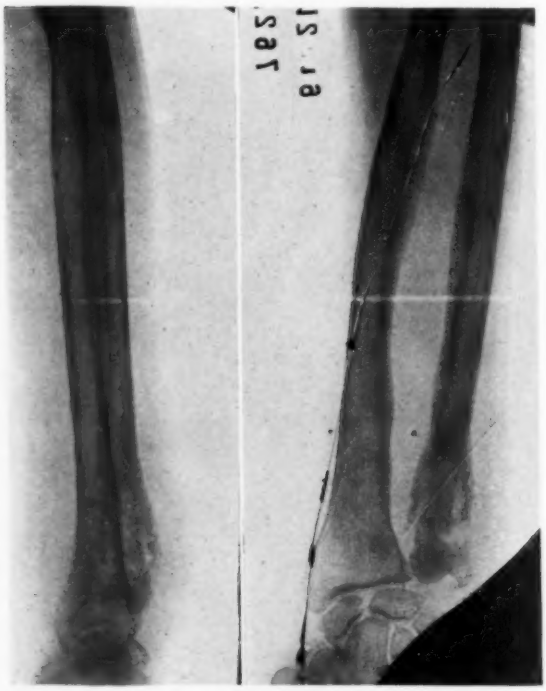

FIG. 5. Pathological Diagnosis: Tuberculosis ulna. There is a line of absorption just above the epiphyseal region; the other changes are almost entirely periosteal. The soft tissues in this region are very much thickened.

Periosteal Changes Due to Typhoid. This is a rare condition in the bone and most frequently attacks the spine and ribs, less often the long bones. The vertebrae are blurred and indistinct when the spine is involved, but the intervertebral discs are not destroyed, as in Pott's disease.

Typhoid of the long bones appears on the *x*-ray plate as a circumscribed area of rarefaction in the cortex, accompanied by a thickening of the cancellous bone in the immediate vicinity of the diseased part. Occasionally there may be a local or extensive periostitis accompanying the area of destruction in the cortex. But there are no special characteristics by which it can be distinguished by means of the *x*-rays from the usual types of inflammation.

Periosteal Changes in Leprosy. In leprosy the bones of the hands and feet show the most marked changes. The lesions are characterized by a variable degree of atrophy and are generally accompanied by a periostitis. Honeij[4] summarizes the bone lesions as follows: "In general the bone changes observed vary from thinning, atrophy, or periostitis, to advanced changes with total absorption of phalanges, marked inflammatory action in the bone, distortion, ankylosis and fractures. Changes may begin in the corticalis, or medullary canal, and apparently any or all of these changes may occur in the same set of bones." The periosteal changes in leprosy alone may be difficult to distinguish on the roentgenogram from syphilis, but the characteristic changes that go with it, together with the history and clinical

FIG. 6. Hypertrophic pulmonary osteoarthropathy. Marked increase in periosteum which has a peculiar moss-like appearance, and the process is limited to the periosteum.

course, render a mistaken diagnosis highly improbable.

Periosteal Changes in Pulmonary Osteoarthropathy. It is generally conceded that this rare condition follows the absorption of toxins from a septic focus, most often primary in the lungs. It has been found to accompany bronchiectasis, empyema, lung abscess, pulmonary tuberculosis with abscess formation, malignant neoplasms, and congenital heart disease. Locke[5] considers clubbing of the fingers an early symptom, but there are cases reported in which it is absent. The hands and the feet as a rule show marked enlargement, accompanied by tremendous bone production in the periosteum, as shown on the roentgenogram. There may be seen a clear space between the bone and the periosteum giving it the appearance of being stripped up. The early process is seen first in the distal ends of the distal bones. Later these bones usually show the most marked changes. No bone is exempt except those of the head and face. The bone itself shows no changes.

FIG. [7.] Scurvy, well advanced. Note [separation of periosteum and displacement of the epiphysis due to hemorrhage.

Periosteal Changes in Osteitis Deformans. The etiology of osteitis deformans seems as obscure as when Sir James Paget[6] first described the disease in 1876. He regarded the condition as the result of chronic infection. It is most commonly seen after the age of forty, though cases are recorded in the literature as early as eight and as late as seventy-nine years of age. The condition does not tend directly to shorten life, and there is no racial predisposition or immunity to the disease. The bones and soft tissues of the hands and feet may be enlarged; the skull when involved is the most characteristic. As a rule, the disease involves more than one bone, but may be limited to a single bone, most commonly the tibia.

FIG. 8. Periosteal sarcoma. Note the characteristic radiating line.

The roentgenogram shows thickening of the cortex on both sides, usually more pronounced on one side than the other. Lime salts are deposited beneath the periosteum, and the new periosteal bone is laid down parallel with the cortex. As a result there is marked overgrowth of the bony structures and abnormal trabeculation.

Perhaps osteitis deformans is most often mistaken for certain types of syphilis.

In osteitis deformans there is frequently marked bowing of the tibia, due to actual enlargement of the bone. There may be pathological fractures, which are, as a rule, accompanied by very little callous formation, whereas in syphilis, fractures are seldom seen, and then only as the result

FIG. 9. Pathological Report: Periosteal sarcoma. Note the periosteal bone proliferation extending into the soft tissues on either side of the shaft and erosion. There are no lines running perpendicular to the shaft.

of very severe violence. In syphilis the epiphysis is seldom involved, whereas in osteitis deformans it usually takes part in the general process.

Periosteal Changes in Rickets. Rickets is a chronic acquired disease occurring most often during the first two years of life. All the tissues in the body may be affected, but the principal pathological changes are seen in the long bones. The most important changes are in the epiphyseal line and neighboring joint. The diaphyseal end of the shaft flares outward and its edges become irregular and jagged. A moderate degree of periostitis sometimes occurs in rickets. The shafts of the long bones, more especially the lower extremities, are frequently bent, showing a thickening of the cortex on the concave side of the curve. Thickening of the cortex on the convex side of the curve, accompanied by a periostitis, is usually due to syphilis.

Periosteal Changes Due to Scurvy. Scurvy, like rickets, is usually seen during the first years of life. The radiogram shows no changes in the epiphyses or the epiphyseal line. The earliest evidence of the disease is the appearance of a white line two to three millimeters behind the epiphyseal line and parallel to it. The white line frequently looks like a second epiphyseal line on the roentgenogram. In scurvy, periostitis is frequently accompanied by hemorrhages beneath the periosteum. At first the subperiosteal hemorrhages may be unequally distributed, so that the periosteal elevation may appear irregular and uneven, over the entire length of the shaft of the bone. The subperiosteal hemorrhages soon undergo organization and mineral salts are deposited in the periosteum as well as in the blood clot.

Periosteal Changes in Bone Tumors. Periosteal neoplasms usually lay down new bone perpendicular to the shaft. Since all the periosteal neoplasms produce new bone in much the same manner, the *x*-ray cannot differentiate the various types, but in the vast majority of cases the benign can be separated from the malignant on the roentgenogram as well as in the gross specimen.

These tumors are most common in young people and seem to have a peculiar affinity for the bones around the knee. These are bone-producing tumors, and the malignant type often grow very rapidly. In the malignant type the new bone appears on the roentgenogram as fine calcified striae, radiating at right angles to the cortex and terminating freely in the soft tissues. The shaft and the periosteum may show a more or less

marked degree of destruction. But the majority of the changes are outside the bone proper. These radiating spicules, when present, make this tumor probably the most characteristic of all the bone tumors, and they have been called "spikes" by some writers. Baetjer[7] refers to these characteristic radiating spicules as "resembling the rays of the sunset."

Occasionally syphilis may lay down new periosteal bone perpendicular to the cortex, but in this case the fine striae of mineral deposits arch together at their terminations, instead of terminating freely in the soft tissues.

I wish to thank Dr. George W. Holmes for his assistance in the preparation of this paper.

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THE INTESTINAL RATE AND THE FORM OF THE FECES*

BY FRANCIS LOWELL BURNETT, M.D.

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A MEASURE of time on the circulatory and respiratory systems has been established for many years and found useful. The pulse beat and the respiratory rate are of value not only in the determination, but also in the consideration of the outcome, of morbid processes. The intestinal rate, however, has received scant consideration; but as the tissues of the body are dependent on the amount and kind of assimilation, which is due to the proper chemical reduction, which in turn is nicely adapted to the rate of passage through the different parts of the tube,[1] an understanding of the variations of the intestinal rate and the form of the feces is likely to prove valuable in the most essential process—proper nourishment—and the maintenance of a harmonious body.

The study previously given to the time taken by substances to pass through the alimentary tract has been in attempts to define the normal rate; but the results have been so at variance that they are without practical value. Thus Hurst,[2] by means of barium and the *x*-ray, says the rate depends on the time of ingestion and defecation, and gives figures from nine to thirty-three hours. Then Case[3] believes that the colon should be empty by the end of thirty-six hours; but Barclay[4] says that there are plenty of women in whom the opaque meal takes forty-eight hours or longer to reach the rectum. And Straus,[5] by the use of carmine, gives twelve hours as the minimum and forty-eight as the maximum for normal limits. Finally, I have suggested that the normal time is about sixty-four hours.[6] Such variations are readily explained in a large series of determinations; especially when it is found possible to change the rate in a subject by dietary treatment.

In this investigation of the intestinal rate the estimates were made by the study of 40 plates in *x*-ray exposures taken five, ten, twenty-five and fifty hours after the ingestion of a barium meal; but more often by seeds given 60 subjects in 250 tests and observed in about 1,000 stool examinations. The tests counted were only those of subjects having one or more natural dejections daily. An illustration of the *x*-ray method is shown in Figure 1. This picture represents two series of exposures; in the upper, showing a rapid intestinal rate, only a little barium remains in the gut after twenty-five hours. Such a condition is associated with soft and formless feces, as shown in Figure 3. In the lower, most of the barium is apparent in fifty hours, and in the sigmoid it is

* From the Skin Clinic of the Massachusetts General Hospital.

formed into discrete masses. This condition is associated with feces entirely formed in units as shown in Figure 5. The upper

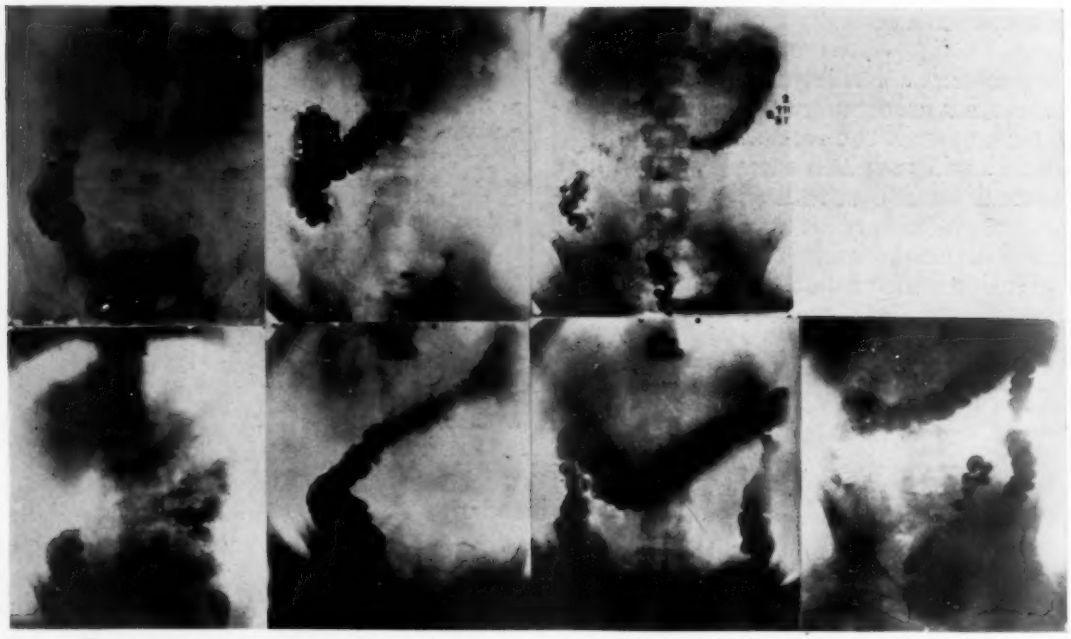

FIG. 1. Roentgenograms of two subjects taken five, ten and twenty-five hours, and one fifty hours, after the ingestion of a barium meal.

series was taken of a patient with psoriasis, whereas the lower was of an unusually healthy individual.

another means was devised, which though simpler, is sufficiently accurate to give very striking results. By this method a measure of 50 c.c. of French millet seed was given a subject immediately after an evening meal. Then the subsequent

FIG. 2. Semisolid feces (diarrhea).

FIG. 3. The soft and formless type.

FIG. 4. A stool formed with marks.

FIG. 5. Feces entirely composed of units.

While the *x*-ray method is applicable in a large hospital, it is too intricate and expensive for general use; accordingly dejections were examined, and the time noted when more than five seeds were first and last seen. In this way the number

of hours elapsing from the time of ingestion to the appearance of the seeds represents the initial rate; while from the time of ingestion to the hour when the seeds were or even fifteen hours. Then in Figure 7, specimens illustrating a retarded rate are shown; and indicate a change from fifteen or twenty-four to thirty or thirty-

FIG. 6. Two specimens illustrating an accelerated intestinal rate.

last seen is the measure of the final rate. That is to say, if seeds taken on Monday at 6 p.m. were first seen on Tuesday at 8 a.m., the initial rate is fourteen hours; and then if they continue to be apparent until Thursday at 8 a.m. the final rate is sixty-two hours. With such a rapid rate the stool is always soft and formless, like Figure 3. On the other hand, when the seeds pass through the gut at a moderate speed, with an initial rate of about twenty-five, and a final rate of about ninety-seven hours, the feces are formed with marks, as shown in Figure 4. And finally with a slow rate of about sixty-two and one hundred and thirty-four hours, the feces are entirely formed in discrete masses or units, as shown in Figure 5.

These figures represent a uniform speed of the intestinal contents in their passage during the test; but very frequently the rate varies and becomes accelerated or retarded, and then there is a corresponding change in the form of the feces. The specimens shown in Figure 6 illustrate an accelerated intestinal rate. Such dejections are always large, and exhibit several different features, as units, marks and formless portions, and show a change in the initial rate from sixty to twenty-four six hours. These specimens are always small and are composed of small units.

The object of this study has been not only to correlate the intestinal rate with

FIG. 7. Two stools indicating a retarded intestinal rate.

the form of the feces, but actually to retard the rate, in order to get patients with eczema and psoriasis on a unit basis, and in this way relieve intestinal indigestion.*

* A paper on Intestinal Indigestion in Eczema and Psoriasis is being prepared.

The treatment consists in refining the alimentary mixture; by this means the intestinal rate is retarded, as shown in Table 1. We have been led to believe that a slowing of the intestinal contents is always the cause of autointoxication, and a great many secondary conditions of disease. This form of food poisoning undoubtedly does occur, but evidently in those with an unrefined mixture. From a study of a few of these patients such a mixture generally evokes a rapid intestinal rate.

Some of the estimates actually obtained are as follows:

TABLE I

A			B		
Date		Rate	Date		Rate
22	X	15–39	18	VII	12–23
29		15–39	25		15–88
6	XI	16–63	1	VIII	24–X*
13		16–63	8		49–118
20		16–85	15		15–117
27		16–64	22		15–102
31	XII	18–85	29		15–X*
28	I	15–89	5	II	63–184

C			D		
Date		Rate	Date		Rate
7	VII	25–96	8	I	63–135
12		24–48	15		63–115
3	X	64–X*	22		87–134
7	I	17–42	29		63–146
29		43–115	5	II	63–146
12	II	44–113	12		63–147
27	III	45–96	19		39–160
24	IV	64–139	26		63–160

* Not observed.

A was a patient with constipation and eczema, who found on refining the alimentary mixture that his movements became more regular, without laxatives, and that the eczema improved. B had psoriasis, and improved on dietary treatment only. C was another psoriatic, who, while on a unit basis and a slow intestinal rate, recovered entirely. At this time he felt unusually well, but got careless about his diet, changed his rate to 17–42 and with the accompanying change in the character of his stool had another attack. Finally he resumed treatment, once more got on a unit basis with a rate of 64–139, and the lesions have disappeared. D is an unusually healthy individual having had a slow rate of about 63–147 for many years. Estimates of the intestinal rate are of practical value in keeping a check on patients having previously been subject to dietary errors, as shown in Table II.

TABLE II

E		
Date		Rate
1	XI	38–145
10	XII	39–148
11	II	50–110
6	III	49–145

The significance of the semisolid form of the feces or diarrhea, as shown in Figure 2, is sufficiently obvious to require comment. The soft and formless dejection with an irregular surface, in contrast with one formed with marks, or more particularly with one of marks and units too, must have some meaning. Such pronounced features in two of the types must be due to some of the functions of the gut; and in order to compare these features with the actions, it is well to review the intestinal motility. In general there are three essential forms of motility; rhythmic segmentation in the small intestine, peristalsis

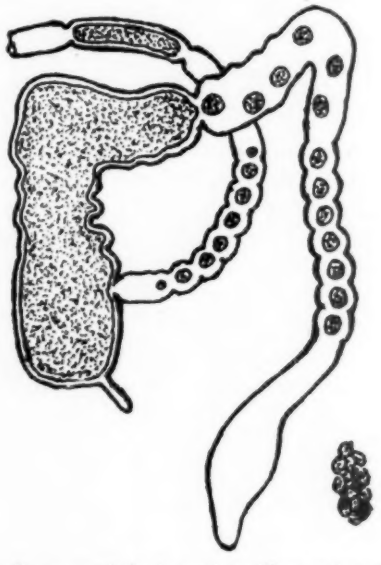

FIG. 8. A diagram of the intestines illustrating the three most essential forms of motility: rhythmic segmentation in the small gut, peristalsis and antiperistalsis in the proximal colon and haustral segmentation in the distal colon.

and antiperistalsis in the proximal colon, and haustral churning or segmentation in the distal colon. These functions are shown diagrammatically in Figure 8. The action of the small intestine need not be taken into consideration, as it probably does not influence the form of the feces. On the other hand, after the soft and

pultaceous material has been kneaded back and forth in the proximal colon, it is formed into discrete masses by the action of a series of constricting rings in the intermediate colon, as shown in Figure 9. Then these small masses or units are evidently a sign that the ingested material has completed peristalsis and antiperistalsis in the proximal colon. In the distal colon the units travel slowly onward by the movement of Fischl and Porges, but are once more acted on by constrictions of the gut in haustral churning or segmentation. Case[7] says this process is similar to rhythmic segmentation; and so the marks or lines shown on the units and specimens formed with marks are evidently due to this function. Accordingly the significance of the forms of the feces without doubt is thus; the unit form of the feces is an indication that the intestinal contents have completed the three essential forms of motility of the gut; the one formed with marks is an indication of rhythmic and haustral segmentation. Such a contention is not only borne out by figures on the intestinal rate, but also by success in the treatment of cases. Specimens formed with marks will appear after a while if the patient follows directions; but the unit form of the feces requires long-continued and exacting efforts to produce.

Is it possible to consider the significance of the feces further, and call one normal, and the others abnormal? The soft and formless dejection is a common type. On the other hand, the unit form of the feces is in the first place similar to the normal form of the higher animals. In the second place it conforms to the physiology of the gut; and in the third place the requirements necessary to produce it are exacting, and when not fulfilled the stool changes to a soft and formless condition, as shown in Figure 6. Finally, individuals found regularly on a unit basis are unusually healthy, and those changed to this basis by treatment—without the aid of any other measures—have improved in health, and been relieved of very resistant forms of eczema and psoriasis. Therefore it is difficult not to say that the unit form of the feces is normal; and that the intestinal rate of about sixty and one hundred and thirty-four hours always accompanying this form, is normal. In this way the form of the feces affords a very definite and immutable means of determining two heretofore unrecognized conditions of the body. One is intestinal indigestion as determined by the soft and formless stool. Such a condition is always associated with malnutrition and may be with an excessive or peculiar putrefaction of the intestinal

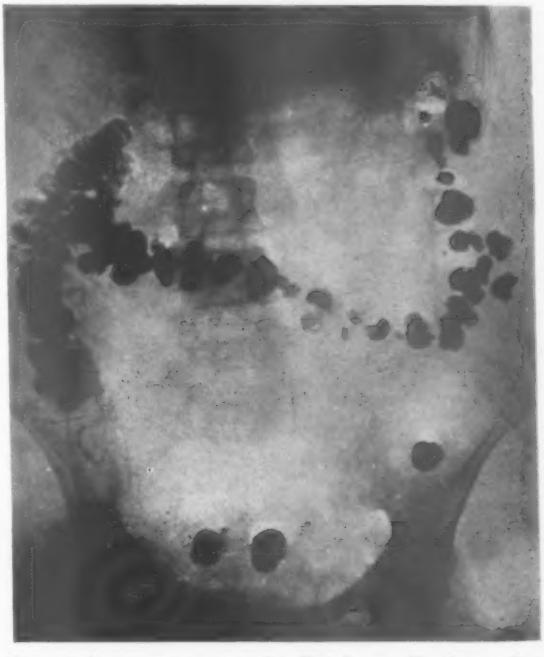

FIG. 9. A roentgenogram by Dr. James T. Case taken fifty hours after the ingestion of a barium meal, and showing a disposition of the colonic contents similar to the previous diagram.

contents; and these factors may be the cause of secondary conditions of disease. The other is an improved state of well-being, as determined by the unit form of the feces. In this condition the individual evidently receives the nourishment in amount and kind that should be obtained from the food; and to keep on such a basis should prevent some secondary conditions of disease, in the maintenance of a harmonious and healthy body.

In conclusion, it is evident that there is a definite relation between the time taken by the aliment to pass through the gastro-intestinal tract and the form of the feces. For stools having an initial rate of fourteen

hours and a final rate of sixty-two hours are soft and formless; those with a rate of twenty-five and ninety-seven hours are formed with marks, and those at about sixty-two and one hundred and thirty-four hours are entirely composed of units. Then accelerated and retarded rates are associated with stools of distinctive features. Again these rates and features of the feces evidently bear some relation to the intestinal functions in operation; and as one entirely composed of units is similar to the normal form of the higher animals; as it conforms to the physiology of the gut; as the requirements necessary to produce it are exacting and when not fulfilled it changes to a soft and formless mass; and finally, as certain patients, changed by a course of treatment from dejecting a soft and formless stool to one entirely composed of units, become relieved of some very resistant forms of disease; it is difficult not to say that the unit form of the feces is normal. Accordingly the form of the feces affords a means of determining two heretofore unrecognized conditions of the body; one is intestinal indigestion with soft and formless stools; the other is an improved state of well-being with fecal units and an intestinal rate of about sixty-two and one hundred and thirty-four hours always accompanying this form.

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A BUCKY DIAPHRAGM WITH WIDE SLITS

BY W. L. SNIDER, M.D.

HOT SPRINGS, ARKANSAS

MR. R. B. WILSEY, in a recent article on the Bucky diaphragm, has demonstrated that the efficiency of the diaphragm depends entirely upon the ratio of the width to the depth of the slits, but not upon their actual size. Also that the definition obtainable with the diaphragm depends chiefly upon the distance between the object and the film. Therefore, to conserve detail the grid must be kept as thin as possible, which necessarily limits the size of the slits.

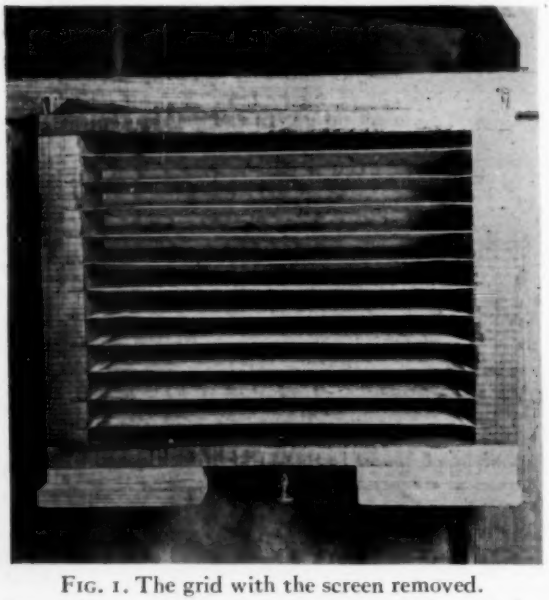

Fig. 1. The grid with the screen removed.

It is well known that definition is improved as you increase the distance between the plate and the target, especially for objects somewhat distant from the plate.

By using a plate-target distance of 7 ft., a grid consisting of slits 1 in. wide and 4 in. deep may be used without any loss of detail.

Such a grid may be made stationary, as the opaque plates are so far apart that their shadows do not interfere with vision.

This grid was devised to assist in making fluoroscopic examination of the heart and vessels. Working at 7 ft., natural-size tracings may be made directly on the screen.

The opaque plates are made of 18-gauge sheet iron, as they are stiff enough to stay in place without intervening material to support them.

REPORT OF THREE UNUSUAL ABDOMINAL CASES*

BY CARL H. PARKER, M.D.

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THE first case is a mesenteric cyst with the rather unique feature that it casts a very definite shadow on the *x*-ray plate, thus making a pre-operative diagnosis possible.

In practically all of the previously reported cases of mesenteric cyst, it was only at the time of operation or autopsy that the diagnosis was made with any degree of assurance. Most of the cases come to the attention of the surgeon either because of an acute intestinal obstruction simulating, in many instances, an intussusception in a child, or as instances of abdominal mass, without features that are sufficiently characteristic to make pre-operative diagnosis certain. In several of the reported cases, roentgenological examination has been of little or no assistance, because the cyst contents did not cast a shadow differentiating the cyst from surrounding structures outside the bowel. Fortunately, in this instance, the cyst shadow was very easily seen.

I wish briefly to review the four different ways in which mesenteric cysts are thought to arise. They are all the result of embryonic accidents, but these accidents may be of different kinds:

1. Cysts developing in misplaced structures derived from retroperitoneal organs.
   (*a*) Germinal epithelium
   (*b*) Ovary
   (*c*) Wolffian body
   (*d*) Mullerian duct.
2. Dermoid cysts.
3. Cysts of intestinal origin.
   (*a*) By sequestration from the bowel during development.
   (*b*) From Meckel's diverticulum, when it arises from the convex side of the bowel.
4. A fourth cause has been suggested because of the chylous character of the cyst contents in many cases, i.e., that the cyst develops from one of the primary lymphatic sacs which are the embryonic beginnings of the entire lymphatic system.

In support of the idea that some mesenteric cysts are of intestinal origin is the observation of Lewis and Thyng: "There is a regular occurrence of intestinal diverticula, especially in the upper part of the small bowels, in the embryos of the pig, the rabbit and man." Quoting further: "Such a diverticulum, growing down between the layers of the mesentery and then becoming sequestrated, might easily be the basis of a mesenteric cyst, or persist as one of the diverticula seen in adult life."

If these theories represent facts, then the 3 cases I wish to present are all instances of embryonic accident, and are therefore related, although widely different in their manifestations clinically:

1. A case of mesenteric cyst.
2. A case of patent omphalomesenteric duct.
3. A case of diverticulum of the small bowel arising at the junction of the duodenum and jejunum.

CASE I. Male, aged four years.

Clinical History. Three weeks ago the patient ate some green plums, which upset his digestion for a few days. He vomited after castor-oil, had some fever and felt "dumpy." Since he recovered from that trouble he has been apparently well. Two years ago he had a similar attack, at which time the physician, Dr. Ball, discovered a mass in the abdomen, close to the navel, about the size of a big walnut. That mass is still present. It feels smooth and firm, and can be moved about through a diameter of a couple of inches, although it feels as though it were fairly well fixed at the base to the mesentery, or some such structure. It is now, in the father's opinion, not quite so prominent as it was two years ago, because then a localized enlargement of the abdomen could be seen. At no time has the boy had any serious illness. He has had no accident, and does not complain of pain or tenderness in the epigastric region. He has palpable glands in both cervical regions, one or two under each arm, and a few in each groin. His color is good. He has gained well in

* Paper submitted leading to membership in THE AMERICAN ROENTGEN RAY SOCIETY, 1921.

weight, height and strength. He has five brothers and sisters, all of whom are well. Parents are well, and have not been sick since he was born. He has lived all his four years in Los Angeles County. The examination is made to determine the character of the mass within the abdomen. The boy is apparently perfectly well and free from all symptoms which might fairly be attributed to the mass.

Radiographic Findings. Plates were made of the abdomen prior to the administration of the opaque meal. In these plates two abnormal shadows are noted. The larger is nearly circular, and 4 cm. in diameter. The smaller is elliptical, 25 × 18 mm. in size. Both of these shadows present a density which is comparable to the bone of the transverse processes of the lumbar vertebrae. The density is not uniform. On the larger of the two shadows there is a circular outline that suggests a nubbin. Taking plates prone and supine, the prone position gives much the clearer plate, which is evidence that the mass lies to the front, where it seems, on palpation, to be just within the abdominal cavity.

The opaque meal, of sweet milk and barium, was administered. No abnormality or defect of the stomach could be detected. The mass lies below and not attached to the stomach. As the meal passed through the small intestine, there was no evidence of obstruction, and the intestinal coils surround the mass as though they were displaced by the mass itself. The mass is in close relation to the right half of the transverse colon. It can be readily pushed away from the cecum, but when pressure is made on the upper portion of the mass in an effort to displace it downward, one point of the transverse colon is adherent at one point to the mass. It is evidently not obstructing the passage of the food content through the bowel. In the lateral view the mass shows with its posterior border about in line with the front of the vertebral bodies. The appendix shows filled with barium, but it is not fixed or tender.

The interpretation of the findings is as follows: The circular shape is evidence that we are dealing with a cystic growth. It is movable. An apparent posterior attachment shows a relationship to the mesentery. The regular borders and the large size of the greater of the two masses, the lack of fixation and the uniform density are evidence against these shadows being due to mesenteric glands.

FIG. 1. Mesenteric cyst before the administration of barium. The metal markers outlined the large cyst with the patient on his back. The movability of the cyst is indicated by the change in position, as shown in the illustration with the patient prone.

FIG. 2. Mesenteric cyst. Stomach outlined by barium meal.

FIG. 3. Mesenteric cyst. Colon outlined by meal. The cyst was made more distinct by palpation during the making of the plate.

Radiographic Diagnosis. Mesenteric cyst.

Operative Findings. Operation by Dr. J. H. Breyer. At operation a multilocular cyst of the mesentery of the small intestine was found. It was not adjacent to the bowel, but was completely surrounded by the layers of mesentery. The contents closely resembled sebaceous material, though no analysis of the contents was made. No calcification was present. The cyst was enucleated, and the patient made an uneventful recovery.

livered three weeks ago in normal manner. When the cord separated, a few days later, small amounts of fecal material began to escape from the umbilical stump. There has been a protrusion looking like everted bowel about ¾ in. in length from the umbilicus. The baby is gaining well on breast milk.

Radiographic Findings. A meal of barium and breast milk was administered, but this passed through the intestinal tract without our being able to differentiate the abnormal loop from the other intestinal

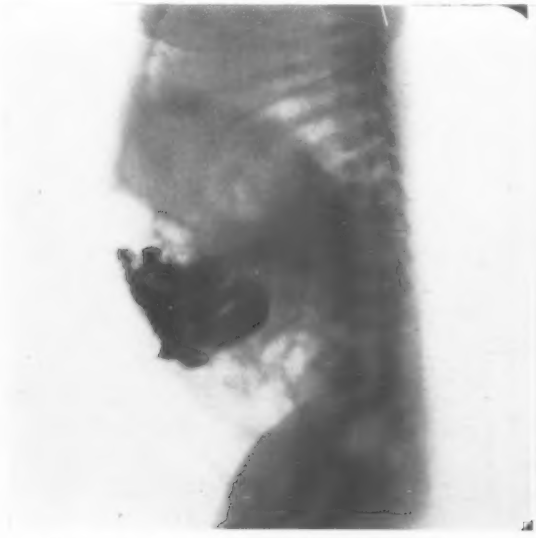

FIG. 4. Patent omphalomesenteric duct. The barium has been injected through the opening at the umbilicus. The barium appeared to enter a normal coil of small intestine immediately below the umbilicus.

FIG 5. Patent omphalomesenteric duct. The injected material has passed into the large bowel. Barium is still to be seen in the duct as it passes through the abdominal wall.

Postoperative Pathological Report. "Examination of the cyst and lymph-node removed has been made with the following results: The lymph-node shows simply an inflammatory hyperplasia. The cyst is made up of very dense, coarse fibrous tissue with a slight amount of granulation tissue on the inner surface. In this granulation tissue was found a large amount of blood corpuscles and a considerable amount of altered blood pigment, so there must have been considerable hemorrhage into the cyst before operation. There was nothing to indicate the nature of the processes to cause a cyst." Dr. S. P. Black.

CASE II. Infant, aged three weeks.

Clinical History. This patient was de-

coils. Accordingly, a barium mixture was gently injected through the umbilical opening. Figure 4 shows where the barium passed into the distended loops of intestine. The part of the bowel filled by the barium would appear to be the mid-portion of the small intestine, as shown by the barium mass and the position in the abdomen. The omphalomesenteric duct or patent Meckel's diverticulum leading from the umbilicus to the bowel could not be identified because the barium appeared to enter the small intestine immediately below the abdominal wall. Figure 5 shows the condition several hours later, with the injected material principally in the large intestine, and a small amount of barium in the abnormal loop. This case has

not been operated upon, hence further findings are not available.

CASE III. Male, aged fifty-two, miner.

Clinical History. A diverticulum of the small intestine at the junction of the duodenum and jejunum is worthy of report because of the difficulty that was encountered in differentiating the diverticulum from a ruptured gastric ulcer with an accessory pocket. The patient was referred for examination principally because of a very severe persistent asthma, which had been present for approximately three years. His history, so far as it relates to the digestive tract, was as follows: He has had more or less trouble with his digestion ever since he can remember, in the way of constipation. He has had an inadequate movement about every day, and every few days was obliged to take a pill or an enema in order to clear himself out. When his bowels were "tied up" he would frequently vomit bile, have a sour stomach and a lot of gas. He has never thrown up blood or passed blood by bowel, that he recognized. He has had no particular pain or soreness in the abdomen, and never has thrown up food remnants taken hours previously. He has been in mining camps for years, where he has lived either in eating-houses or alone. In either case he was forced to eat what was handy. He has been a periodical drinker. After a week or two of drinking he would have a bad stomach, but, he stated, no worse than it has been at other times. No clear account of relief by food taking or other trouble characteristic of ulcer of the stomach could be obtained.

Radiographic Findings. The barium meal passed into the stomach without evidence of obstruction. Only a few swallows of barium had been taken when the screen was centered over the stomach and the patient was instructed to drink the rest of the buttermilk. As the meal began to fill the stomach and distend the antrum, it was noted that the stream coming down the lesser curvature deviated somewhat to the left an inch or two below the cardia, while the apparent outline of the stomach extended too far to the right at this point. Directly opposite on the greater curvature was a deep incisura of spasm that could be relaxed for a few seconds by pressure and then recurred. On the lesser curvature side and behind there seemed to be a pouch of the size of an egg, which filled about one-half with barium and showed a distinct fluid level topped by a gas-bubble. The main part of the meal showed the usual gas-bubble at a much higher level toward

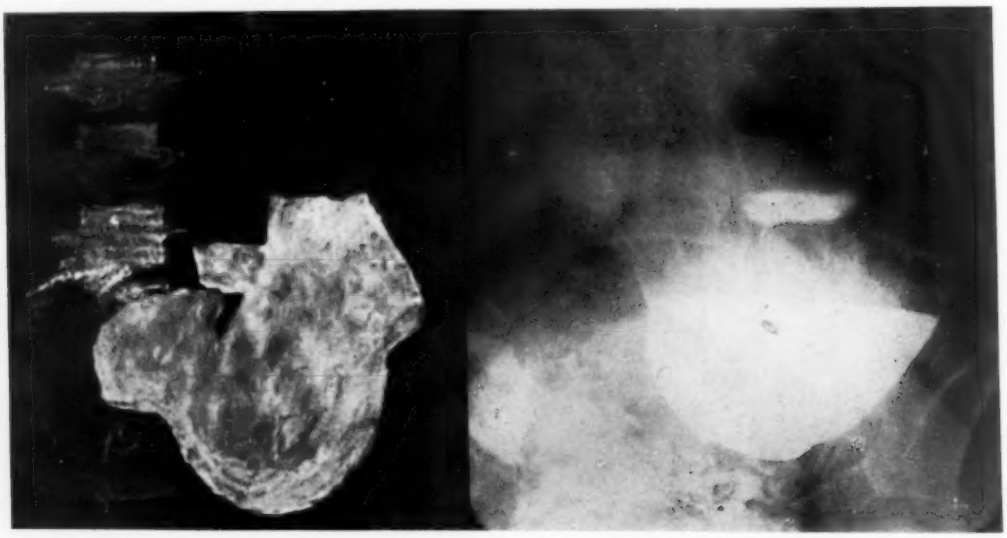

FIG. 6. Diverticulum of the third portion of the duodenum. Tracing of stomach and diverticulum filled with barium, patient erect. The fluid level in the stomach is above that in the diverticulum.

FIG. 7. Diverticulum of the third portion of the duodenum. Made one hour after administration of the barium. The fluid level in the diverticulum is now well above that in the stomach. Patient erect.

the cardia, and as digestion and emptying of the stomach progressed, at a much lower level than that of the pouch. Figure 6 shows the appearance that was noted immediately after the taking of the meal, with the patient in the erect posture. The fluid level of the stomach is seen distinctly above the fluid level in the pouch, which is about half full. By making pressure with the hand the pouch half full of barium could be outlined as entirely distinct from the rest of the stomach, but no connection between the stomach and the pouch could be demonstrated. In the prone position, the

FIG. 8. Diverticulum of the third portion of the duodenum. Tracing of plate made at twelve hours. The meal is in the large intestine while the diverticulum still contains some barium.

pouch appeared as a protrusion on the lesser curvature side, but not distinct from the rest of the stomach. No tenderness was elicited by pressure. The meal began to pass through the pylorus immediately, and so far as could be noted the pyloric region and cap were not involved. In Figure 7 it will be noted that a considerable amount of barium has passed through into the small intestine, that the pouch is about one-fourth full, and that it presents a distinct fluid level well above and separate from the fluid level in the main portion of the stomach. In Figure 8, made at twelve hours, the bulk of the meal was seen in the large intestine. Considerable residue was still present in the pouch. Below the stomach no evidence of pathology was encountered in either small or large intestine, as the meal passed through. On May 21st, several days after the other inspection, a second meal was administered. Barium water was given first, then the usual buttermilk mixture, and with neither was there an immediate filling of the pouch. A decided spasm was present at first, holding the meal in the cardiac portion of the stomach, but soon a relaxation allowed the meal to fill the antrum. A plate made at this time showed a perfectly normal stomach outline. By pressure to the right and slightly upward, the pouch was partly filled, and appearances exactly duplicating that found at the first meal were noted. Three and a half hours after this meal the body of the stomach was almost entirely empty, but the pouch contained a residue 2½ in. in diameter. At six hours the stomach was empty, and a barium shadow an inch across persisted at the site of the diverticulum.

An examination of the chest shows marked thickening of both hilus regions, but no shadow indicating pathological processes in the parenchyma of the lung. Films of the few remaining teeth in the lower jaw are negative for abscess, but present evidence of a considerable absorption of bone at the alveolar margin, due to a pyorrhea process.

Radiographic Diagnosis. Ulcer of the stomach with accessory pocket posterior to the stomach.

Further History. At operation a few weeks later, when the stomach was exposed, both the anterior and posterior walls of the stomach were carefully inspected, and no appearance indicative of pathology could be discovered. A careful search of the duodenum at first revealed nothing unusual. However, traction on the jejunum brought down a diverticulum, which extended upward and to the right from the bowel just where the duodenum emerges to form the jejunum. This diverticulum was of approximately the same caliber as the jejunum. It was about 4 in. in length, and left the small bowel at approximately a right angle. The stoma was of the same caliber as the rest of the diverticulum. No inflammation was noted about the diverticulum, which was entirely surrounded by peritoneum, so that it was easily clamped and removed in much the manner that is ordinarily used in disposing of an appendix.

The patient made an uneventful recovery from the operation. Since that time he has returned to the desert, and in spite of repeated efforts to learn of his condition, no replies have been returned. No data is available as to the effect of the removal on either his digestion or his asthma.

This case was of particular interest because it so clearly simulated the findings seen in perforating ulcer of the lesser curvature or posterior wall of the stomach with accessory pocket. I believe that had I been alert to the possibility of encountering a diverticulum in this location, a correct diagnosis could have been made by roentgen examination. It is also interesting to note that the diverticulum was hidden beneath the superior mesenteric fold, and was found during the surgical exploration only after the most careful examination of this region, in an effort to explain the roentgenographic findings.

LOCALIZATION OF BRAIN TUMORS BY CEREBRAL PNEUMOGRAPHY*

BY WALTER DANDY, M.D.

BALTIMORE, MARYLAND

THE results in surgery of the brain, as indeed in all branches of surgery, have been greatly modified by inadequate and inaccurate knowledge of the situation, as well as by the character of the lesion. It is doubtless known to all of you that tumors of the brain are exceedingly difficult to localize. Usually we may say with a fair degree of assurance that the patient has a tumor of the brain, but the localization of the tumor requires all the resources at our command. The great silent areas of the brain—silent because we do not yet know their function—harbor these growths of tremendous size and give to the host no indication of their situation by signs or symptoms.

The roentgen ray has now become our assistant and it is also our greatest detective. With its aid, I should say practically all brain tumors should be located. A considerable portion of them (as a guess probably 15 to 20 per cent) can be located solely by shadows which the tumors cast, by virtue of calcification and also by the destructive effects upon various parts of the skull. In other cases the evidence, while not pathognomonic, is helpful and corroborative. With these results, however, you are all thoroughly familiar.

In at least 35 per cent of brain tumors the injection of air into the ventricles of the brain aids tremendously the function of the *x*-ray, and by its usage we can locate the remaining group of tumors which cannot be located in other ways It is the results in this particular group—about 35 per cent—which I wish to bring before you.

For this procedure air is substituted for cerebrospinal fluid; that is, fluid is withdrawn from the cavities of the brain and air is substituted, thereby changing the density of certain parts of the cranial chamber. To do this, fluid is withdrawn from a lateral ventricle and air injected in equal amount. The air casts a shadow in precisely the same way as opaque media produce shadows in the genito-urinary or the gastrointestinal tracts, shadows being of course due to differences in density. From the changes which are found by contrast with the normal cerebral ventricle in size, shape and position, we are able to deduce the situation of the tumor; for all tumors which give signs of intracranial pressure will produce some change in the shape, size or position of one or more of the ventricles. By that I do not mean that all brain tumors distort or change the size, shape and position of the ventricles, but that all brain tumors *which give symptoms of pressure* produce one or more of these changes, which should make a diagnosis possible.

Brain tumors give rise to two types of signs or symptoms: (1) those of localizing character, (2) those of general pressure. If the patient has localizing manifestations, the localization of the tumor is made

*Read at the Fourth Annual Meeting of the Eastern Section of THE AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 25–27, 1923.

without the use of the *x*-ray or without the use of air injection. If there are no localizing symptoms, the only other symptoms which the patient can have are those of pressure. Therefore, it can be said that practically all brain tumors *which give symptoms* can be localized, either by the localizing symptoms or by the use of the *x*-ray with or without the injection of air.

To Dr. Baetjer is due a large share in the credit of developing this procedure. He has always been most eager and willing to clarify the difficulties and I feel that without him we would have had a very difficult course to pursue.

We have seen tumors of the frontal, temporal, parietal and occipital lobes; tumors in the ventricles; tumors in the cerebellum and brain stem.

There is one group of tumors in which the use of air is less absolute. This is the group which gives a bilateral hydrocephalus and in which two lateral ventricles communicate freely. All we can say from the ventriculograms is that we have a lesion between the aqueduct of Sylvius and the foramen of Magendie, but with very few exceptions this is sufficient information to allow us to find the tumor at operation. If we know that a patient has hydrocephalus, then we should be able to find the tumor at operation; that is, the operations which we now have are adequate to find practically any tumor.

Just a word as to the procedure. It is very dangerous. There has been a tremendous mortality from its use. However, if judiciously used and only by one thoroughly skilled in intracranial surgery, the danger is minimal. I had three deaths at the beginning of my series. Since then, I have had none. If properly handled, it should carry very little danger to the individual; and certainly the danger in proper hands is small compared to the dangers attending cranial operations based upon guesswork.

In the treatment of brain tumors, as in surgery elsewhere, we must have an accurate diagnosis and a precise localization. If we do not have these, our surgery is bound to suffer. The treatment of brain tumors particularly calls for very formidable procedures, which should not be misplaced.

There are many pitfalls in interpretation of *x*-ray findings. It is certainly not a simple foolproof interpretation; it requires much experience. We have made mistakes in our interpretation and it is only as our experience widens that we have attained an assurance that the localization can be made with a high degree of certainty and precision.

For practical purposes we shall deal principally with the ventricular system. You will note the 4 cerebral ventricles, 2 lateral ventricles, the 3rd ventricle and the 4th ventricle. It is also necessary to understand the physiology of the circulation of cerebrospinal fluid. All cerebrospinal fluid forms in the ventricles of the brain but does not absorb there. It absorbs outside of the brain. For this reason, if there is a tumor blocking any part of the ventricular system, there will be a dilatation of the ventricular system ahead of that obstruction. If we were to trace the course of a drop of fluid after it forms in the anteriormost part of the ventricular system until its absorption, we would find it passes through the lateral ventricle to the foramen of Monro; if the foramen of Monro is blocked, this entire lateral ventricle must distend because there is no other outlet for the fluid, exactly as an obstructed ureter causes distention. Continuing the normal journey of the drop of fluid, it passes through each foramen of Monro into the 3rd ventricle, and from the 3rd ventricle there is only one point of exit—the aqueduct of Sylvius. All fluid which forms in both lateral ventricles and the 3rd ventricle must pass through the aqueduct of Sylvius. If, therefore, you have a block in the aqueduct of Sylvius, the 3rd and both lateral ventricles must become distended. There is no other possibility of escape for this fluid. Again continuing the course of this drop of fluid through a patent aqueduct of Sylvius, we find that it enters the 4th ventricle; and leading from the 4th ventricle there are three openings, two foramina of Luschka and one of Magendie. From these the fluid pours into the cisterna magna, whence it is distributed into the

absorbing spaces of the brain on its exterior. The fluid passes downward into the spinal canal and upward into the subarachnoid spaces which cover the whole brain. If you understand the absorbing parts of this circulatory system and understand that the fluid must reach them to be absorbed, you can understand why dilatation of the ventricles results from tumors; and therefore, when you get dilatation, you can infer the location of the obstruction which causes it. The location of that obstruction will, of course, be the location of the tumor.

In perspective, the ventricular system will actually appear. Each lateral ventricle occupies approximately the center of a cerebral hemisphere, and you can see the relative positions of the foramina of Monro, the 3rd ventricle, the aqueduct of Sylvius, the 4th ventricle and the foramina of exit at the base (the foramina of Magendie and Luschka). The spinal fluid in the cerebral ventricles has only these three outlets (closely approximated) for the escape of all the cerebrospinal fluid.

For practical purposes the vast majority of tumors are diagnosed by the effect which the tumors have on the two lateral ventricles. The 3rd also has an important field, as well as the 4th, but most are localized through the effects on the two lateral ventricles.

You can see that if there is a tumor in the frontal lobe, the anterior horn of this ventricle will be compressed. If that tumor becomes large enough it will obliterate this part of the ventricle and close the foramen of Monro. If, then, air is injected into the ventricle, it could not escape from or into this ventricle (depending on the ventricle injected) because the ventricle is occluded. Complete occlusion of the ventricle occurs in a large percentage of tumors in this region. This, of course, represents relatively late stages of the tumor's growth.

Obstruction in any point of the ventricle will be demonstrated by the inability of the air to pass beyond it. An obstruction in a ventricle would cause distention of the ventricle ahead of it and would have no effect upon the size of the ventricle behind the tumor. A tumor in the 4th ventricle would produce hydrocephalus in the same way, but there would be this striking difference: the lateral ventricles would not communicate with each other. The difficult region for precise diagnosis is between the aqueduct of Sylvius and the foramen of Magendie.

To describe the operation necessary for the procedure: A small opening is made on each side of the skull. We always make two openings, one for each lateral ventricle. A large tumor will often occlude one ventricle so that it cannot be reached, but the other ventricle will usually be attainable. The posterior opening is chosen because this part of the ventricle is largest and easiest to reach.

As to the method of injection of air, the needle is inserted through the skull opening into the posterior horn of the ventricle. Cerebrospinal fluid is aspirated from the ventricle and ejected; unsterilized air is aspirated into the syringe and forced into the lateral ventricle. An amount of air equal to the amount of fluid removed should be injected; by turning the head in the proper way the air can be shifted at will to any part of the ventricular system.

DISCUSSION

DR. KERR. It is a great pleasure to be here tonight as your guest. I appreciate the opportunity not only to be with you, but also to discuss Dr. Dandy's valuable paper on cerebral pneumography.

Dr. Dandy has given us a very brilliant addition to cerebral surgery in establishing and proving the value of air injection as an aid to the localization of brain tumors. As he so aptly said, all surgery is dependent on diagnosis; and the more exact and more perfect the diagnosis, the better the resulting surgery.

We all feel that surgery of the brain is just on the threshold of a brilliant future. It is by the researches of such exceptional students as Dr. Dandy that neurosurgery can be improved. Step by step the high mortality and unsatisfactory results can be eliminated. As in surgery elsewhere, such results demand early diagnosis —not a diagnosis of brain tumor when the patient is blind, paralyzed and helpless, so that if a tumor is removed only a useless life is prolonged, but a diagnosis which permits us to localize the lesion and remove it in the early stages and return our patient to a useful life.

Dr. Dandy's ventriculography, as he first termed it, was given to the profession some years ago. Sufficient time has elapsed to allow an estimate of its worth. We must decide whether cerebral pneumography does or does not help in the localization of brain tumor. We have to balance its value against its danger; we must study its faults or shortcomings, if it has any, and elaborate on the technique to improve the results or reduce the mortality. Although it is too early for many of us to speak in this way, because we have not had the experience or developed the skill of Dr. Dandy, we can make certain statements.

There is no doubt that a certain proportion of cerebral tumors are not definitely localized by neurological studies. If cerebral pneumography will clear up the diagnosis in this group, we can then say that all tumors are localizable. It that true? In Dr. Dandy's hands it is, but in the hands of other surgeons who do neurological work, I do not believe it is. I do not believe we have reached the stage where we can localize by cerebral pneumography all the cases which are not definitely localizable by neurological studies. There are cases where cerebral pneumography will not give definite localization. There are cases where cerebral pneumography may even be misleading. We know that there are abnormalities of the ventricles; that, particularly in the posterior horn, there may be variations from the normal that may lead us to an exploration that proves negative.

I have had two such cases: one in which I felt sure of the position of the tumor. An exploration in that region was negative. In the other case, I was also misled by a posterior horn defect. We now know that there are variations from the normal that we must beware of and must consider in localizing occipital lobe tumors. In the large tumors that make gross deformities of the ventricles, the vast majority are so gross that they produce definite neurological symptoms that will suggest the localization without pneumography.

Where the localization is not clear-cut by other studies, or where there is a question between two possible sites, then cerebral pneumography should prove out one or the other localization. In cases where the lesion is small, where it has not grown to a size to produce gross deformity of the ventricle, we will not get the same definite and gross evidence as we will in the large tumors. If the tumor is in the so-called silent area, we may have no neurological signs of its location. It is in these cases that cerebral pneumography may indicate a successful exploration where we may hope for radical surgery early enough to return our patient to a useful life.

Now as to the dangers. In the hands of other neurological surgeons—again contrasting them to Dr. Dandy—there is a mortality. This is difficult to estimate, but from personal reports it is roughly somewhere in the neighborhood of 3 per cent. In my experience the mortality is higher in hydrocephalic cases. We must remember that when we remove cerebrospinal fluid which has been under pressure from the dilated ventricles of hydrocephalus, pressure has been exerted on the choroid plexus. Just as in the evacuation of any obstructed secreting gland in the body, when the pressure is removed the secretion is re-established, and it perhaps re-establishes at a relatively greater rate than had occurred before. Therefore, if we remove the fluid from a dilated ventricle whose choroid plexus has been under pressure, and replace it by a much more elastic medium, air, the choroid plexus returns to function—perhaps increased function—and we have a rapidly increased pressure in the dilated ventricle. I feel it is important, therefore, in these cases, to remove the air after the roentgenograms have been obtained and your records made. One of my fatal cases died, I feel sure, from this occurrence. Another case showed marked increase in pressure after a cerebral pneumography, but on the removal of the air came around to normal again.

If cerebral pneumography has a mortality of say 3 per cent in the hands of the average neurological surgeon, it must and will undoubtedly have a larger mortality among general surgeons. We must not allow cerebral pneumography to suggest to the uninitiated a rule of thumb and simple way of locating brain tumors. We must warn of the mortality and the need of experience in making as well as interpreting cerebral pneumograms.

In cerebral pneumography we have a distinct addition to the study of the location of brain tumors. The whole thing is a brilliant conception and I feel the profession joins me in most hearty congratulations to Dr. Dandy for his contribution.

Dr. Baetjer. Dr. Dandy was kind enough to say some very nice things about the work that the *X*-Ray Department has done, but I would like to have it understood that the entire conception of this work is his own. The question of position, the question of filling the ventricles, the question of emptying the ventricles and the various ways in which the head is placed are entirely Dr. Dandy's ideas. I have been fortunate enough to see the development of brain surgery for over a period of twenty years, and I realize how inadequate the *x*-ray

examination, particularly in the early days, was in many instances to give help to the brain surgeon. I have seen the development of air injection into the ventricles from the very beginning, and there have been a great many difficulties to overcome.

Dr. Dandy has shown you some of the plates and has given you the diagnosis. One might be inclined to think that it was a very easy method of examination. I have seen him study these plates by the hour, day after day, before arriving at any definite conclusion, and then check up by operation. What knowledge I may have of the diagnosis of these conditions has been entirely due to Dr. Dandy. The accuracy of diagnosis in this particular line of work is increasing steadily, and I feel that with the constant study of these cases examined by the air method we will come pretty close to 100 per cent accuracy. I feel that Dr. Dandy's work in this particular line marks tremendous advance in this most difficult line or work.

Dr. Kennedy. Dr. Dandy's work is one of the best contributions that has been made to cerebral surgery in the last twenty years. I think, however, that in order to appraise it properly we would have to know very definitely the details of his whole series.

Dr. Dandy said in his address that only 50 per cent of cerebral tumors are localizable. That, I think, is an underestimate. It is very important, of course, to investigate cases of brain tumor with the utmost exactness, because only very frequent and thorough examinations will bring out the small data necessary to arrive at a diagnosis. We feel as neurologists, and the surgeons I am sure will agree, that our technique in pneumography is very much behind. It has been so much behind that we shall have to take the matter very gravely. A great many of our pneumographs are but shadows chasing shadows. We have not, in the majority of our cases, derived from them the information needed. Dr. Dandy says that 15 per cent of tumors are localizable or discoverable by the *x*-ray, apart from pneumography. That I thought was a rather high percentage; and it differs, if I remember rightly, by 10 per cent from Dr. Dandy's figures published in 1918. At that time I think he said 5 per cent, which even then struck me as a high average, because in my opinion the *x*-ray has been very unfruitful as a method of investigation of tumors apart from a massive tuberculum which, of course, is frequently calcified and throws a very definite shadow.

Dr. Dandy said that by pneumography we will be able to restore the entire balance of those cases which are undiagnosable by neurological examinations. That is rather a wide statement and I am sure that Dr. Dandy does not mean it to be taken quite literally. As Dr. Kerr pointed out, there are natural abnormalities in the shape and size of the ventricles of which one cannot be aware beforehand. Furthermore, there are tumors, a whole series of them, published by Spiller, in which an edema is produced, not around the tumor, but in another part of the brain. This, of course, would deform the ventricle in the wrong place. Then again, there is great difficulty, as was shown by Dr. Dandy, in the fact that a meningitic exudate will block entire ventricular connections as effectively as any tumor. A little while ago I published a series of cases of inflammation of the brain and meninges in the course of which there developed tremendous papillo-edema; in those cases hydrocephalus must have been of quite sudden onset and must have been due to the laying down of meningitic exudate at say the foramen of Monro, producing a bilateral enlargement of the lateral ventricles. Such cases, if pneumographed, would, of course, produce pictures which would look like a posterior fossa tumor, and it is quite difficult to say how one can distinguish between general hydrocephalus and the production of a hydrocephalus in the 4th ventricle.

Dr. Dandy said that this was a procedure which should be employed only in cases not otherwise localizable; but I noticed that he had some instances of tumor of the pineal. That is very astonishing because in our experience, tumor of the pineal produces very clear-cut symptoms by reason of its pressure on adjacent structures.

I would like to say, however, how much I admire his technique in the production of an artificial foramen of Monro. That is as brilliant a piece of surgery as has ever been my privilege to see, and I admire the courageous imagination which prefaced this technique. I believe I admire still more the enterprise and the audacity with which Dr. Dandy attacks the growths when diagnosed. The neurological surgeons have been too much to the Right politically speaking! They have not had enough of the radical about them. Dr. Dandy is on the extreme Left! That is a good thing. It is courageous conduct which will make neurological surgery a living thing.

It occurred to me to give you an instance here and there of neurological diagnoses made on what seemed minute evidence properly appraised. There came to me, while I was listening to Dr. Dandy's paper, the recollection of a girl who came to the hospital under my care with all the general signs of cerebral tumor—very severe headache, severe vomiting, etc. We watched her for a space of three or four weeks,

I think, and we had no indication whatever to give us an idea where to operate. We thought of course, that her tumor, if she had one, must be in a large so-called silent area and we examined her particularly for evidence of derangement of the temporal and frontal lobes. She developed fatigability of the right abdominal reflexes. They were not gone, but depressed. One day I showed her a number of objects and asked her to name them and she did so accurately. I took a fountain pen and she hesitated and said, "Now isn't that queer? That is one of those patent pens." On that we operated and found a left-sided temporal tumor. It was inconceivable that a girl who used a fountain pen every day should forget its name and have to use circumlocution, which, of course, is the first thing done when the posterior part of the 1st temporal gyrus is affected. I remember a man who was a police sergeant; he arrested a man guilty of misdemeanor and when he grasped him by the arm to take him to the station he could not release his grasp. He had to take his other hand and undo the fingers one by one in order to get loose. Shortly after that the symptoms continued; when he closed his fist he could not open it again. Then he developed headaches and came under our observation. On that symptom we believed he had a tumor involving the corpus callosum. He developed a slight sign of pressure on the right side. We believed, in view of the fact of this condition in the arm, that he had a lesion. This was proven by operation.

I thought it was worth while to mention such a couple of incidents at random to show that it is necessary to learn each other's language; that a lot of Dr. Dandy's photographs, to the eye not instructed in their significance, might look like cloud effects; their exact significance does not come to the eye. Also in neurological examinations phenomena arise which are of pregnant meaning. The instructed and the uninstructed would have to learn each other's language in order to cooperate; and I have to say that Dr. Dandy's work makes me very anxious to learn his. I think he has contributed enormously to the advancement of his art and science and to ours.

Dr. Pancoast. This is a difficult subject to discuss from the *x*-ray standpoint, because the roentgenologist plays a very small part in the whole procedure, although he does play a very important part. The technique as carried out by the roentgenologist is, of course, a most important one and must be precise and efficient.

We all look upon Dr. Dandy as the man who has developed this method of diagnosis and placed it where it is today, and we must all look up to him for our knowledge of the procedure and the interpretation of our findings.

I can say nothing concerning the technique of the neurosurgeon, but he is absolutely dependent upon the work of the roentgenologist. I have examined just enough cases to know that if the men in this audience go home with the idea that they can start out in this work and be successful, they will find themselves greatly mistaken. You cannot interpret your own plates, for this is a procedure which takes much experience, an accurate knowledge of brain anatomy and familiarity with brain tumor pathology. We have examined 45 cases, but this is a very meager experience, and we have much yet to learn before we can approach anywhere near the accuracy of diagnosis of Dr. Dandy and Dr. Baetjer.

After familiarizing yourselves with brain anatomy, it will be a wise plan to study specimens in a laboratory of neuropathology, in order to learn just what a tumor does to the ventricles. I recently spent an afternoon with Dr. Spiller in the laboratory of neuropathology of the University of Pennsylvania, for this very purpose, and my conception of the subject was considerably modified by what I saw. I was very much struck by the number of specimens of tumor in which there was an enlargement of a part or all of the hemisphere on the side of the tumor, and which Dr. Spiller and others ascribe to an overgrowth of neuroglia tissue. Attention has just been called to this by the last speaker, Dr. Kennedy. Even in the case of small tumors, far away from the ventricles, this overgrowth of tissue seems to encroach upon the ventricles, and is likely to be misleading in the interpretation of the ventriculogram. This condition is found not only in connection with tumors, but is also associated with traumatized areas.

In one brain there was a very striking condition which would undoubtedly have led to error in case cerebral pneumography had been attempted. At about the middle of the lateral ventricle on one side there were some dense adhesions practically dividing it into two portions. Lower down in the ventricular system there were other adhesions causing a moderate internal hydrocephalus. This was a syphilitic case.

The work in our laboratory has been carried out in conjunction with Dr. Frazier's clinic, and his associate, Dr. Grant, and I have worked out most of the cases. We have spent many hours working over cases and trying to improve our technique; but by sitting beside Dr. Baetjer here in this room, I have learned many valuable technical points as Dr. Dandy has proceeded. His technique is quite different

in many respects from the one we have employed, and we shall certainly put into practice many of his ideas in the future. We have always placed our plates on the up-side of the head, with the tube under the table. Dr. Baetjer works in the reverse manner. I can readily see, however, that it is absolutely essential to empty the ventricles of all fluid in such a procedure; otherwise air-filling defects due to fluid remaining in the dependent ventricles will give fallacious results.

I have also learned from Dr. Dandy that it is very necessary to tap and inject both ventricles. Many failures we have had can be ascribed to omission of this. Exact centering of the tube and head is essential in order to find slight lateral deviations of the lateral and third ventricles. The head must be so placed in the fore-and-aft views as to throw the lateral and third ventricles above the frontal and ethmoid cells. Lastly, I am convinced that the Bucky diaphragm is essential for the detail required in the films.

I agreed to discuss this paper because, first, I thought I would learn something by so doing, and second, I wanted to tell of some of the difficulties we have encountered and to emphasize them by slides, hoping that Dr. Dandy and Dr. Baetjer could assist me over some of our troubles.

Dr. Dandy (closing discussion). I do not know that there is much more for me to say; after Dr. Baetjer's talk I feel very much embarrassed. You are all familiar with his great modesty concerning his own accomplishments.

Dr. Pancoast brought up the possibility that adhesions might be confused with tumor. There is no way to tell the character of the lesion. It can only be said that the lesion is located at a certain point, and in all probability can be found.

I have just gone over the statistics of tumors in the past year. This may be of interest, particularly in answer to Dr. Kennedy. I do not know precisely the number of localizations from the use of the *x*-ray alone—they were about 7 per cent in 1914—but they have increased considerably, for the *x*-rays are now much improved and our interpretations are superior. I should venture the guess that now at least 15 per cent of tumors can be localized by the *x*-ray alone. In a very high percentage of cases, compared to previous times, we can find actual shadows of calcification in the tumor. I think the localization of 50 per cent of tumors from neurological signs and symptoms, i.e., excluding the *x*-ray, is a pretty liberal estimate, and I doubt that it will come up to 50 per cent.

In 1914 we went over our cases, probably 70, and we could localize about 50 per cent with all means at our command. That included two or three and sometimes more operations.

During the last year we had 101 tumor cases; 4 of these died before operation (no injections of air). Of the 97 cases which we were able to study, 95 tumors were actually disclosed at operation. One of the 2 missed was a patient who was deeply unconscious at the time. The site of exploration was based upon an attack of Jacksonian epilepsy which was seen by his physician before the onset of coma. The other was a tumor in the brain stem which we made no effort to disclose. Of the 95 tumors found at operation, 6 required two operations, i.e., 89 were found at one operation and 6 in two operations. One of the 6 cases which required two operations was a case I saw with Dr. Kerr, a boy with hydrocephalus but with a small deformed ventricle on one side—a secondary feature possibly not related to the tumor. At the second operation a cerebellar tumor was found. Another one of the 6 cases was misleading because of decompression which was previously done and this decompression destroyed the value of the normal. The other 4 cases had hydrocephalus due to tumors of the pineal body or the hypophysis. Two of these had previously had air injected, and in two the air was injected after the operative failure. Of these 97 cases we used air in 35; in 62 we did not use air. It is, roughly, in 1 out of 3 cases that air has been necessary. There is one other feature which I have not mentioned. Twice I have operated for a tumor on the basis of air and the tumor has not been found. Both of those cases subsequently came to autopsy and neither had a brain tumor. One had a tumor in the spinal cord giving choked disc, headache and loss of eyesight. There are many conditions in the central nervous system still not understandable, and this is one of them. The other case was a boy who was blind, had headaches and choked disc. He had no tumor whatever. Our diagnosis of an occipital lobe tumor was largely by exclusion because the remainder of the ventricular system was normal and a tumor was considered a certainty. Had I verified the readings of the posterior horn, as should have been done, this part of the ventricle would doubtless have been shown to be normal at the second reading. It is very easy to misinterpret these roentgenograms, and, as Dr. Baetjer has told you, it requires a great deal of study. In reply to the view expressed by Dr. Kennedy that pineal tumors should be diagnosed by endocrine manifestations: tumors of the pineal body only at times give such symptoms. In only 1 of our 5 or 6 pineal tumors have any so-called glandular symptoms been manifested.

DERMATITIS ARTIFACTA SIMULATING ROENTGEN DERMATITIS

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IN this article attention is called to the fact that self-inflicted injuries, lesions and eruptions, that may be classified under the general heading of dermatitis artifacta (malingering; dermatitis factitia; feigned eruptions; neurotic excoriations, etc.) may spontaneously or accidentally simulate roentgen or radium dermatitis; also that malingerers may intentionally and more or less successfully imitate a roentgen or radium dermatitis. In the latter instance the object is revenge, to avoid work, to collect insurance, to excite sympathy, interest, fear, etc.

The fact that self-inflicted eruptions may simulate roentgen or radium dermatitis to a degree that will deceive the inexperienced or the unwary, is of scientific interest and of medicolegal importance.

For obvious reasons, details such as would tend to identify the patient are omitted from the case reports contained herein.

MALINGERING VERSUS ROENTGEN DERMATITIS

Case Report. The patient, a woman, thirty-two years of age, was first seen by us on Nov. 18, 1920. She gave the following history of the evolution of the eruption for which she had been referred in consultation:

She had had a roentgenological examination of the left superior maxilla on August 22, 1920. A roentgenological examination of the antra was made on Sept. 1, 1920. On this latter date a second examination was made of the superior maxilla. Two weeks later (Sept. 15, 1920) the left cheek became inflamed, the inflammation being accompanied by a burning sensation. One week later (Sept. 22, 1920) an area of similar inflammation appeared on the back of the head and neck. A third area of inflammation developed on the back of the left wrist about a month later (Oct. 25, 1920).

When we first saw the patient (Nov. 18, 1920) she presented an irregularly square-shaped area of dermatitis on the dorsal surface of the left wrist. The dermatitis consisted of moderate erythema and slight exfoliation. The affected area was sharply outlined and about 2 in. square in size. On the left cheek there was an area of moderate erythema and slight exfoliation, about the size of the palm of a child's hand. The area was round, but it was not sharply outlined. On the back of the head there was a sharply outlined area of rather intense erythema with considerable exfoliation. It was round in shape and about the size of an adult hand. It was situated on the back of the neck, the upper part extending above the hair line. There was no defluvium capillorum.

It was noted that the degree of dermatitis (intensity of inflammation) varied considerably throughout the three areas. That is, scattered throughout each area were small areas of greater and lesser intensity.

The patient stated that an intense burning sensation was constantly present, but that at times the erythema became less and even disappeared in places only to return within a few days. She averred that the inflammation had been severe and associated with edema (skin very red, hot and swollen) but that there had been no ulceration or excoriation. It was ascertained that the inflammation in each area appeared suddenly and reached maximum intensity within twelve hours.

The patient had been seen by a number of physicians who accepted the diagnosis of roentgen dermatitis without discussing differential diagnosis. The roentgenologist who made the exposures was perplexed and perturbed but he, too, accepted the diagnosis of roentgen dermatitis and ascribed the unexpected result to idiosyncrasy.

We disagreed with the diagnosis on the following grounds:

1. The inflammation on the cheek appeared two weeks after the last exposure. That on the back of the head occurred three weeks after the exposure. The area on the wrist was first noticed six weeks after exposure. It is difficult to reconcile these findings with a knowledge of roentgen dermatitis. However, the possibility of "delayed reaction," variations in susceptibility of different parts of the body and variations in the quantity of radiation reaching the three areas, had to be considered.

2. The sudden appearance of the eruption and its rapid development are not characteristics of roentgen dermatitis.

3. The burning sensation was constantly present but the inflammation was alternately better and worse. This would not occur in roentgen dermatitis unless caused by the intermittent use of irritating topical remedies. The patient had been using ointments and lotions which were said to be of a soothing nature.

4. The contour of the lesions did not seem compatible with the known facts regarding the exposures. The patient was certain that she had held the film in the left side of the mouth with the left hand and that the back of the wrist was facing the tube. Such a position is awkward and unusual but it is possible. The roentgenologist could not recall how the patient held the film in position. Accepting the patient's statement, the wrist and cheek were exposed at the same time; yet the area on the wrist was sharply marginated and irregularly square in outline; while the area on the cheek was round with ill-defined margin.

5. The intensity of inflammation varied throughout the affected areas as already described. Such variation does not belong to the clinical picture of roentgen dermatitis.

6. The five points above enumerated strongly militate against a diagnosis of roentgen dermatitis. The sixth point, about to be elucidated, makes such diagnosis untenable. The patient had an eruption on the scalp which, if it represented a roentgen dermatitis, would be of a mild second degree. When first seen by us the eruption had been present on the scalp for four weeks, and a period of seven weeks had elapsed since the exposure. In spite of this there had been no defluvium. The scalp hair always falls out three weeks after a quantity of radiation sufficient for epilation has been administered. No dermatoroentgenologist will dispute the statement that a quantity of roentgen rays sufficient to produce a mild second-degree reaction is much more than enough to cause the hair to fall out.

At the consultation the possibility of malingering was suggested because:

1. The affection was not a roentgen dermatitis.

2. The eruption characteristics were not those of any known dermatosis.

3. The evidence pointed strongly to an attempt at the artificial production of an eruption that would simulate a roentgen dermatitis.

Subsequent History. The diagnosis of malingering was accepted with alacrity by the implicated roentgenologist and hesitatingly by some of the other physicians and dentists who were interested in the patient.

We saw the patient next on Jan. 15, 1921. The three areas were still erythematous and scaly. The hair had not fallen out. The affection was still intermittent in character. One of the physicians who was present at this consultation recalled that the patient had apparently feigned an illness several years previously, an illness that had been baffling at the time. Among other supposed symptoms, including feigned hemoptysis, she ran a temperature of 101° F., until it was discovered that the temperature was normal whenever it was taken by someone other than the patient. It is a very simple matter to elevate the mercury in a clinical thermometer by applying friction, with the fingers, to the bulb of the instrument. Also, at this consultation, the patient was told that another consultation would be held in two weeks, and that inasmuch as it was difficult to make a diagnosis and to outline a successful plan of treatment without seeing the eruption at its worst, it was hoped that maximum intensity would correspond with the appointed

time for the next consultation. This is a very old and frequently successful psychological trick used by dermatologists in cases of feigned eruptions.

At the next consultation, Jan. 30, 1921, the picture was typical of malingering. Each area was intensely red with some edema. The intensity of inflammation was irregular, as though an acid had been applied to one small portion of skin at a time, instead of being applied to the entire area simultaneously. The wrist lesion presented one very characteristic feature. There was a streak of dermatitis one quarter of an inch in width, extending from the distal margin of the lesion over the dorsal surface of the hand for a little more than one inch. This indicated that a little too much of the caustic fluid (probably carbolic acid) had been applied and a drop had run down over the hand, producing this pathognomonic indication before the caustic action could be prevented by the addition of alcohol. The wrist lesion also showed two small areas of superficial ulceration. A plaster-of-Paris dressing was advised for the wrist, but the patient refused to use it. She was then made acquainted with the diagnosis and she indignantly denied complicity.

We last saw this patient on Feb. 6, 1923. The cheek was normal. The back of the neck showed irregularly distributed, faint erythema. The wrist area was bluish-red in color and it contained some cicatricial tissue. In this area were three lesions, a little smaller than a dime, consisting of dry, hard, black necrotic tissue, surrounded by considerable inflammation. They were of three months' duration. The patient stated that at various times the lesions consisted of blisters, suppurating ulcers, and simple inflammation (erythema and edema). At times there would be no lesions for several weeks. She still refused to permit the application of a sealed dressing and persistently denied complicity. Malingerers, however, usually deny guilt even when confronted with both circumstantial and direct evidence. There were no roentgen sequelae, such as atrophy, telangiectasia, pigmentation, depigmentation or alopecia on the wrist, cheek or back of the head and neck.

NEUROTIC EXCORIATIONS VERSUS ROENTGEN DERMATITIS

There is another entity falling under the general heading of dermatitis artifacta which, under unusual circumstances, may be confused with indolent ulcers caused by roentgen rays or radium. We refer to the condition known as neurotic excoriations (acarophobia; dermatothlasia; dug-out excoriations; acne urticata; excoriated acne of young girls, etc.).

In this affection the neurotic patient produces the lesion or lesions artificially by daily picking and squeezing the skin with the fingers or with an instrument such as a pair of epilating forceps. The affection differs from malingering in clinical manifestations and also because there is usually no intention of or attempt at deception. The patients will readily admit picking at the lesions and will often submit, for microscopical examination, tiny pieces of tissue which they have removed from a lesion. They are convinced that these tissue shreds are insects or foreign bodies, or in any event that they are the cause of the trouble and must be removed. Occasionally a patient will triumphantly submit a harmless and extraneous insect which has happened to be in or near the lesion. Not infrequently patients are unable to explain why they dig at the lesion; they seem to be unable to control the impulse or desire. Psychoanalysts explain that such habit is due to a misplaced or transferred sex impulse. It is very difficult to overcome or control this habit or mania. The lesion feels uncomfortable; the desire to manipulate becomes irresistible; the lesion feels more comfortable after the patient has worked at it for a while. The original cause of the picking is usually a milium body, a comedo, an inflammatory papule or, in fact, any slight elevation of the skin.

Naturally, the clinical manifestations are varied, and the affection may imitate such diseases as lupus, syphilis, epithelioma, tuberculide, acne, etc. There is one type of neurotic excoriation of special interest to roentgenologists, and that is the single indolent ulcer. This type may closely simulate the indolent ulcer that occasion-

ally follows an acute third-degree roentgen or radium reaction.

We have in our files the histories of two patients which very nicely illustrate the clinical similarity between indolent ulcers produced by roentgen rays and those produced by artificial means. They were both under observation at the same time, so that the similarity was very striking.

One patient, a man, had had an epithelioma for which he received roentgen treatment. The treatment was followed by a third-degree roentgen dermatitis which later developed into an indolent ulcer. The ulcer was as large as a dime and situated on the left cheek close to the ear. It was crateriform (punched out) and presented a dry, glistening floor. The surrounding skin, having been carefully shielded, was clinically normal.

The other patient, a woman, presented an ulcer in the same situation, of the same size and of very similar appearance, but the history and cause were entirely different. The patient, fourteen months previously, had begun to pick at a tiny papule. She would spend an hour or two a day working at the lesion with a pair of forceps. The chronic, indolent ulcer was the result.

As a rule there is no difficulty in differentiating between the two conditions. In the case of roentgen ulcer there is a history of antecedent roentgen treatment and an antecedent acute roentgen dermatitis with severe pain. Also there is likely to be atrophy and telangiectasia around the ulcer. In the case of neurotic excoriation ulcer, there are the history of picking, the probability of multiple lesions, fantastic outlines, alteration in appearance from time to time, the absence of antecedent roentgen or radium treatment and of sequelae around the ulcer. Nevertheless, the two conditions can be so similar as to make a diagnosis by inspection somewhat hazardous. A history of previous roentgen treatment, an admission by the patient of picking at the ulcer, or a confusing, disputed or unreliable history, may make the diagnosis very difficult. It is well to keep these facts and possibilities in mind when giving medicolegal testimony. The next case report illustrates some of these diagnostic difficulties.

Case Report. The patient was a man, forty-four years of age, of nervous temperament and slightly neurotic type. He was referred to us on May 19, 1916, for the treatment of a large, indolent ulcer of two years' duration, situated on the lower part of the left cheek.

Past History. In 1912 the patient consulted a dermatologist for the diagnosis and treatment of an ulceronodular lesion over the left mandible which had been present for several months. The diagnosis was syphilis, but antisyphilitic treatment was not efficacious. In 1913 two dermatologists, working independently, each made a clinical diagnosis of epithelioma. Throughout 1914 the patient was given fractional roentgen treatment by a roentgenologist.

According to the patient's statement, the treated area became inflamed and painful, but the treatment was continued. Finally the pain became so severe that he refused further roentgen treatment. The ulceration then became more pronounced and, finally, indolent. It was the opinion of the patient that he suffered from a chronic roentgen dermatitis. The roentgenologist averred that the ulcer represented an epithelioma which had continued to evolve in spite of roentgen treatment; and that at no time during the course of treatment was there more than a first-degree roentgen reaction.

Personal Observations. When we first saw the patient in May, 1916, there was an indolent ulcer situated over the left mandible. It had remained almost unchanged for over a year. It was 3 in. in length, 2 in. in width and about ¼ or ⅓ in. deep. The walls of the lesion were abrupt, which produced a punched-out or crateriform appearance. The floor of the ulcer was dry and shiny as, also, were the walls. There was no induration at the margins, nor were there any sequelae in the surrounding skin, such as atrophy or telangiectasia or permanent alopecia. The patient stated that the lesion had been exceedingly painful, but that now it was less so.

Our diagnosis was chronic roentgen dermatitis, and this diagnosis was confirmed by the members of the New York Dermatological Society. The roentgenologist vigorously opposed this diagno-

sis. It was his opinion that the lesion was either lupus or epithelioma and that it should receive further roentgen treatment. We could not seriously consider either of these diseases, but we were compelled to grant the possibility of the indolent ulcer type of neurotic excoriations for reasons that will soon be presented.

During the year that the patient was treated by us (1916 and 1917) there was little if any improvement in spite of ultraviolet rays, high-frequency current, strapping, and topical applications. After several months, the patient admitted that there was no more pain and that the lesion was sensitive only at intervals and then only at small points. These sensitive points were of a much brighter red than the remainder of the lesion and varied in location from time to time. These red, sensitive points, together with certain mannerisms and actions on the part of the patient, suggested the possibility of neurotic excoriation. Upon being accused and questioned, the patient exhibited a pocket mirror and a pair of thumb forceps. He admitted that he worked at the lesion several times daily and as long as an hour at one sitting. This had been going on for many months. The patient was obsessed with the idea that tiny pieces of gray tissue must be removed before healing could occur. He stated that if he abstained from manipulating the lesion for any length of time it became very uncomfortable and that considerable relief followed the use of the thumb forceps.

The history of the case was thus complicated, confusing and unreliable. In our opinion the lesion represented a roentgen dermatitis, the manipulation with the thumb forceps being a complicating factor. However, the possibility of the lesion having been caused by the patient had to be admitted. The patient ceased manipulating the lesion, or at least he claimed so, but there was no improvement. Several months later the entire lesion was excised, embedded in paraffin, cut serially, stained in various ways, and the serial sections were studied under the microscope. The pathological histology was that of roentgen dermatitis. The patient made an uneventful recovery and he has had no further trouble. He was last seen in August, 1920.

MALINGERING INTERFERING WITH A ROENTGENOLOGICAL RESULT

The case about to be described has no bearing on roentgen dermatitis, but it is of interest to roentgenologists as it illustrates how a malingerer may interfere with a therapeutic result. In this connection it may also be emphasized that patients with neurotic excoriations may modify the results of *x*-ray treatment. This is especially true in the types represented by Brocq's excoriated acne of young girls, Waelsch's urticaria necrotisans, and Kaposi's acne urticata. These affections may be mistaken for certain clinical types of acne vulgaris, seborrheic acne, acne varioliformis, tuberculide, lichen planus, and other dermatoses. If the patient continues to produce new lesions, or aids in their production, or interferes with the healing of a lesion, and this fact is not recognized by the roentgenologist, the result of roentgen therapy may be disappointing and confusing. On the other hand, when the habit is associated with definite elementary lesions such as comedones, acne pustules or papules, milia, etc., roentgen therapy may overcome or help to overcome the morbid habit by removing and preventing the formation of lesions that cause the desire to pick and dig at the skin. It is probable that many such cases are cured in this way without the artificial element being recognized.

Case Report. The patient was a woman, thirty-one years of age. She was normal physically. Temperamentally, she was phlegmatic, morose and neurotic. Appendectomy had been performed on July 17, 1919. Recovery was uneventful and the wound healed in the usual length of time. About two weeks after healing was complete, the skin became inflamed and the portion of the wound situated in the skin and subcutaneous tissue opened and suppurated. The wound was explored for foreign bodies, but none were found.

We saw the patient for the first time on Jan. 23, 1920. She was still in the hospital and she spent most of the time in bed. Examination revealed a long, narrow,

shallow, rather insensitive ulcer on the right side of the abdomen. It was 3½ in. long, ½ in. wide, and about ⅛ to ¼ in. deep. There was a slight, purulent discharge from one end of the wound. The remainder of the ulcer was dry, and presented anemic-looking granulation tissue. The tissue in and near the wound was markedly infiltrated; in other words, the wound was keloidal and it was supposed that the development and presence of the keloid had prevented the wound from healing.

Five intensive roentgen treatments, at monthly intervals, effected complete involution of the keloidal infiltration. The wound was now soft, the granulations appeared healthy, but it did not cicatrize. Ultraviolet radiation and various topical remedies were tried with indifferent results. At times the wound would almost heal, only to break down again. Finally, the curious behavior of the wound and the patient's temperamental defects directed attention to the possibility of malingering: excoriations and scratch marks were noticed in the normal skin near the edge of the wound; at times the granulations were dry and inactive; at other times they were red and active; occasionally the floor of the ulcer looked as though it had been rubbed and scratched; at the menstrual periods, regardless of the condition of the granulation tissue, the wound, surrounding skin and gauze dressing, were stained a brownish red.

From Aug. 1, 1920, to Sept. 20, 1920, experiments with sealed dressings were conducted. If the dressing remained sealed the wound healed. Usually the dressing was partially or entirely removed by the patient. After healing, scratch marks could be detected in the scar before the wound opened. The patient persistently denied the accusation of malingering. Surgeons occasionally encounter cases of this kind, but the experience is rather unique in roentgenology.

THE INFLUENCE OF X-RAY THERAPY ON BENIGN AND MALIGNANT GROWTHS DEPENDENT UPON AN APPARENT VALID DISTINCTION BETWEEN THEM*

BY GOTTWALD SCHWARZ, M.D.

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IN THE following communication I beg you to count not so much on hearing unknown facts as seeing set forth well-known facts in a new conception, which may have value both for the theoretical problems of malignant growths, and as well, for the much-fought-over question of practical *x*-ray therapy.

Let us first consider the action of *x*-ray energy upon the normal growing cell-groups of the human body, and take as an example an epithelial tissue, the hair. A definite dose of *x*-ray causes a stoppage of growth of the matrix cells. The hair curls up and falls out. The arrest of growth lasts for from several weeks up to months. After this time the uninfluenced remaining matrix cells begin a regeneration of the hair root. The proliferative activity increases more and more and a new hair is formed. There results, so to speak, a recurrence.

If we now remove this re-grown hair again by means of *x*-ray, we find that the application of the same or even a somewhat lesser dose than the first one is sufficient to produce a stoppage of growth and epilation. For a re-epilation of the re-grown hair an increase of the dose is not necessary; rather the contrary is true. Repeated epilation leads most certainly to a definite destruction of the hair root.

A similar relationship exists for normal and benign growths of mesodermal tissue. Let us take, for instance, from the connective tissue group growths, the keloid; we find here also under repeated *x*-raying no decrease, but rather an augmentation

* Read at the GERMAN ROENTGEN RAY CONGRESS, Munich, 1923.

in radiosensitiveness. One can get analogous results in the case of all normal or benign hyperplastic tissues, whether they are of ectodermal or mesodermal origin, so that we can lay down the following rule: *Normal benign growing tissue shows toward repeated x-radiation a uniform or increased sensitiveness.*

Fundamentally different is the case as to the effect of *x*-rays upon the growth of malignant blastomas. It is a phenomenon well known to all *x*-ray therapeutists that both carcinoma and sarcoma, in event of a recurrence (with the exception that I do not refer to the definite late recurrence appearing years after the first appearance) become gradually more refractory to the influence of *x*-rays. This phase is especially emphasized by Rieder in his textbook on radiotherapy; and Jüngling and Kästle have mentioned at a recent *x*-ray meeting in their recapitulation of cases such cellular adaptability or self-immunizing phenomenon to *x*-ray action. I have in mind the striking example of lymphosarcoma in which case after the first exposure to *x*-rays the tumor literally melts away; then after the first recurrence it becomes less sensitive, and finally, with the latest recurrences, it no longer reacts even to the largest doses of *x*-rays. And yet, not only in the case of malignant lymphomas, but in all recurrent sarcomas and carcinomas, one invariably observes this immunization against *x*-ray influence; so that we formulate this rule: *Malignant recurrent anaplastic blastomas exhibit a decreasing sensitiveness to the influence of x-radiation.*

Now if we contrast this diametrically opposite behavior, namely, the unaltered roentgen-sensitiveness of benign growths and the decreasing roentgen-sensitiveness of malignant tumors, then we must finally acknowledge that here lies a fundamental difference, which relates to the principal peculiarities of malignant blastomas in their reaction to *x*-rays. While the benign cell complex, an integral part of the organism altruistic in character, fully transmits to its descendants the property of reacting to *x*-ray damage by an arrest of growth, on the contrary, with malignant blastomas, there is found an increasing resistance to *x*-radiation.

P. S. Meyer has lately reported (*Klin. Wchnschr.*, April, 1923) on the self-immunizing phenomena of the bacillus prodigiosus to *x*-rays. I believe it to be correct to assert that the adaptability of the malignant blastomas to *x*-rays is analogous in character to that observed by Meyer in his work with bacillus prodigiosus colonies. One may see from this example how, by way of cell metamorphosis of the normal into malignant cells, the latter has literally assumed the character of an autonomous, parasitic growth.

Now, if we inquire further as to whether this phenomenon also has, as a basis, a recognizable histological change, we must mention the researches of Aschoff, who, in common with Krönig and Gauss (*München. med. Wchnschr.*, 1913) have seen in the left-over carcinomatous remnants, this metaplasia as one of greater maturity; as, for example, the transformation of nonhorny into horny portiocarcinoma. Differing completely from these findings of Aschoff are those of Ludvig Adler (*Zentralbl. f. Gynec.*, Vienna, 1916) who stated positively that a ripening of the tumors during irradiation is not at all observable and that in all cases where, after exposure to *x*-rays, a recurrence appears, the recurrence has constantly proven itself less differentiated than the initial favorably influenced primary tumor.

Without wishing to bring into this discussion these controversial questions of greater or lesser maturity, it seems to me very important to emphasize the fact obtained from both of the works quoted that morphological changes do occur in the recurrence of mixed-cell type blastoma after periodical *x*-raying, changes which undoubtedly are connected with this particular self-immunizing phenomenon.

In conclusion I wish to present my own conception of the problem which we have before us. While benign cells of a like mother tissue, essentially bound together, are submitted to the same laws of growth, they form, so to speak, a similar cell race; in the other case (malignant growth) one must consider the recent findings of tumor research with experimental tar carcinoma of the mouse and *x*-ray carcinoma which are resulting malignant blastomas, through

the gradual oft-repeated breeding from benign hyperplasia.

In my judgment we must agree that in malignant neoplasms, both benign and malignant elements exist in numerous modifications and combinations, all of which exhibit varying degrees of different *x*-ray sensitiveness.

With the *x*-ray attack acting upon the malignant blastoma two sequences are possible: (*a*) The entire cell group is destroyed, which results in a permanent disappearance or complete healing. (*b*) The *x*-ray sensitive groups are destroyed while the less sensitive groups are only slightly checked or remain uninjured, which is the case of temporary healing or only slight recovery.

If we now analyze the second possibility (which alone is of interest to us) it will be clear that the recurrent tumor will be rebuilt from those cell groups which, through their low *x*-ray sensitiveness, will thereby be protected from permanent destruction.

Thus considered one sees why the recurrent tumor *must* necessarily exhibit a lesser *x*-ray sensitiveness. By elimination of the *x*-ray sensitive groups we have selectively cultivated the lesser sensitive groups. It is my opinion that there is absolutely no doubt but that with all malignant blastomas, the elements of which cannot be completely destroyed by *x*-rays without leaving resistant remnants, we bring about, by means of the *x*-rays sooner or later an evident increase of resistance of the malignancy against the arresting effect of the *x*-rays.

The question immediately arises as to whether this heightening of the degree of malignancy is exclusively an *x*-ray specific or whether it is general. Clinical observations make it probable that the latter is the rule. By no means, however, are we able *a priori* to set aside the possibility that, through such selective pure culture of the tumor cells less capable of being checked in growth, there follows a general heightening of the malignancy, in the sense that the blastoma becomes nonsensitive to *x*-ray influence through repeated exposures and eventually is more refractory to the retarding influences naturally existing in the organism. Naturally we dare not withhold this self-evident possibility in considering the influence of the *x*-rays. For even in the unfavorable cases we succeed in obtaining a temporary lessening of the endurance of the tumor, which improvement cannot be foreseen.

The time at our disposal is too short to discuss the subject in all its possibilities which present themselves in practice, in the conception as here set forth. I wish this communication to direct your attention to this proposition: that we are dealing with fundamentally different biological situations in the *x*-ray reaction of benign tumors and in the *x*-ray reaction of malignant blastomas. Through this it is understandable that while advancement of growth is not demonstrable after *x*-raying in normal tissues (at least successfully until now); in malignant tumors such an acceleration of growth is possible in the sense of a heightening of the malignancy produced by *x*-rays through selective breeding.

RECENT DEVELOPMENTS IN PROTECTIVE METHODS AND APPLIANCES AS USED IN RADIUM THERAPY

BY CURTIS F. BURNAM, M.D., AND GRANT E. WARD, M.D.

BALTIMORE, MARYLAND

IN using radium, especially in large quantities, one is steadily confronted with the problem of protection—protection both of workers and patient. Protection of the workers has been described in an article by Dr. Howard A. Kelly on "The Care of Radium in the Hospital" (*Mod. Hosp.*, May, 1922, xviii, No. 5). We propose to mention here a few important appliances developed since the above publication.

The criteria of an efficient therapy apparatus are (1) It must prevent all radiation of the patient except at the site of disease. Protection against general radiation is essential to guard against a possible anemia from repeated heavy doses over blood-forming organs. A satisfactory apparatus must also protect such internal secretion glands as adrenals and thyroid, as well as ovaries and testicles. Exceptions to this rule are the radiation of large fibroids, large spleens and massive tumors, where any possible disturbances arising from scattered rays affecting other parts of the body are of less importance than an incomplete radiation. (2) The perfect apparatus must permit the cross-firing of deep tumors without allowing the over-lapping of the rays to irritate the skin. (3) It must be capable of perfect fixation when in position. If the apparatus is easily dislodged from its correct position during a treatment there is either damage to the normal part or an inadequate treatment of the disease. (4) It must also be comfortable for the patient, as the treatments sometimes last for several hours. (5) It must be so constructed that it can be adjusted easily and accurately without the least possible exposure to the trained operator. In most of our work the doctor in charge "sets up" the appliance and leaves the room while the nurse, whose duty in the radium department covers a shorter period of time, places the emanation in the applicator (see article cited above). (6) As far as possible it must lessen the exposure of the nurses who handle the emanation.

Guided by these criteria we shall now discuss briefly the various applicators and their relative advantages.

For completeness' sake we mention first the older principle of the plain package, used without lead filtration wherever a general radiation is desired, as in large spleens and fibroid tumors. The package is of felt of a thickness equal to the chosen distance of filtration; is about 2 × 3 inches at the end resting on the skin and is strapped to the bottom of a wooden box with a hinged cover. The prepared package is held in position by long adhesive straps running out to sandbags at the side of the patient. The operator now leaves the room and the nurse enters, carrying the tubes of radium emanation with a long forceps as far as possible from her body, and drops them into the wooden box. As stated, the operator himself rarely handles the emanation, while the nurses charged with this duty are changed so frequently that their total exposure is negligible. This is our procedure in "setting up" all our treatments, with the exception of those special ones which require the more experienced hand in the actual application.

In most cases, lead protection to all parties involved is advisable. Our former method of securing this was a flat or curved piece of lead for the filter, with an opening for the passage of the rays of the size and shape of the lesion in question; the radium was then laid in place on the distal side of the lead, as shown in Figure 1, Diags. A, B and C. We see at once that there are several possible adjustments of a lead filter lying between the emanation and the patient; three positions are shown in Diags. A, B and C. In any of these situations there is of necessity a great scattering of rays (*s*) which travel in all directions. To limit this distribution one of us (G. E. Ward) devised a cylinder whose operating principle is shown in Figure 1, Diag. D; with a longitudinal, sectional view in Diag. E. In such an arrangement with a wall of

1 in. of lead, the scattering is reduced to below 20 per cent of its original intensity, while the rays traveling directly toward the lesion (*d*) remain unaffected and unabsorbed. The filtration of the oblique rays adjacent to the circle (*d*) the area under treatment, is through 2 to 3 in. of lead. In actual use this radium emanation carrier holds many emanation tubes of varying strength. In order to assure a more uniform radiation of the area treated, the strong tubes are placed in the central pockets, jarring the emanation out of place; it is also comfortable, as there is no pressure against the skin. It is easily adjusted so that the operator when leaving the room is confident there can be no mistake in inserting the emanation. By means of the extra lead in the cover of the carrier (see *l*, Diag. D, Fig. 1) the nurse's hands are protected. General radiation of the body is limited and by mapping out the various areas over a large tumor and focusing them at several angles, cross-firing is secured

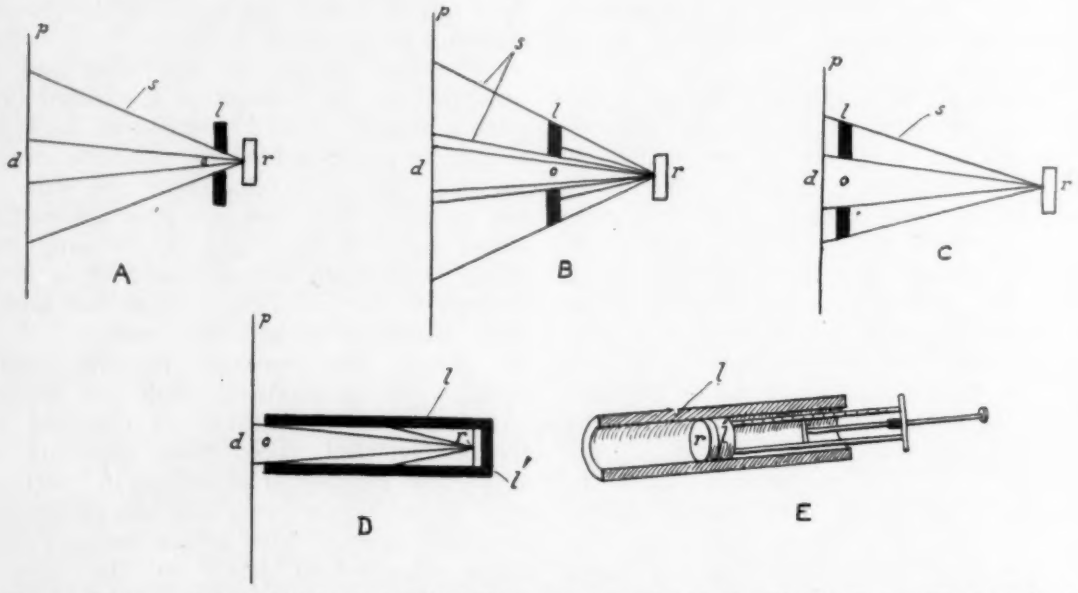

FIG. 1. Diagram of the principle of plain lead filters as compared with the Ward cylinder. The lettering in all diagrams is as follows: (*r*) box containing radium emanation; (*l*) lead filter with portal (*o*); (*p*) skin of patient; (*s*) scattered rays. Diagram A, lead filter (*l*) next to the radium emanation. Diagram B, lead filter (*l*) midway between radium emanation and patient. Diagram C, lead filter next to the skin. Diagram D illustrates how the rays are absorbed by the walls of the cylinder, only those destined to reach the lesion being unobstructed; (*l*) represents 1 in. of lead in the cover of the emanation carrier (*r*) which affords protection of the nurse's hand while she is inserting or removing it from the cylinder. Diagram E, a longitudinal sectional view of the cylinder containing emanation carrier. The latter is equipped with handle to facilitate in manipulation. The length of the handle and the carrier together correspond to the length of the cylinder. A scale is so arranged on the handle that as the carrier is moved in the cylinder the number of inches read at the distal end indicates the distance of filtration.

the weaker ones next, and the weakest in the marginal pockets. The carrier is rotated during the treatment by the nurse by turning its handle clockwise, so that at the end of the treatment it has completed the circumference of the cylinder. Such an applicator meets all the criteria of efficiency.

Figure 2 shows a cylinder in place during the treatment of a parotid tumor; note protection of the eye, ear, shoulder and neck. With this instrument we focus accurately upon the disease without irritating the skin. Whether there is an actual increase in the dosage, due to reflection of the gamma rays from the lead, remains to be determined. Detailed measurements of the width and intensity of the cone of rays at various depths beneath the skin will furnish desirable data as to the actual intensity of treatments at given depths. We believe that the diverging cone of radium rays permits of more accurate focusing than the parallel and therefore narrower beams

of rays from the Coolidge *x*-ray tube, for the deeper the cone of the radium rays

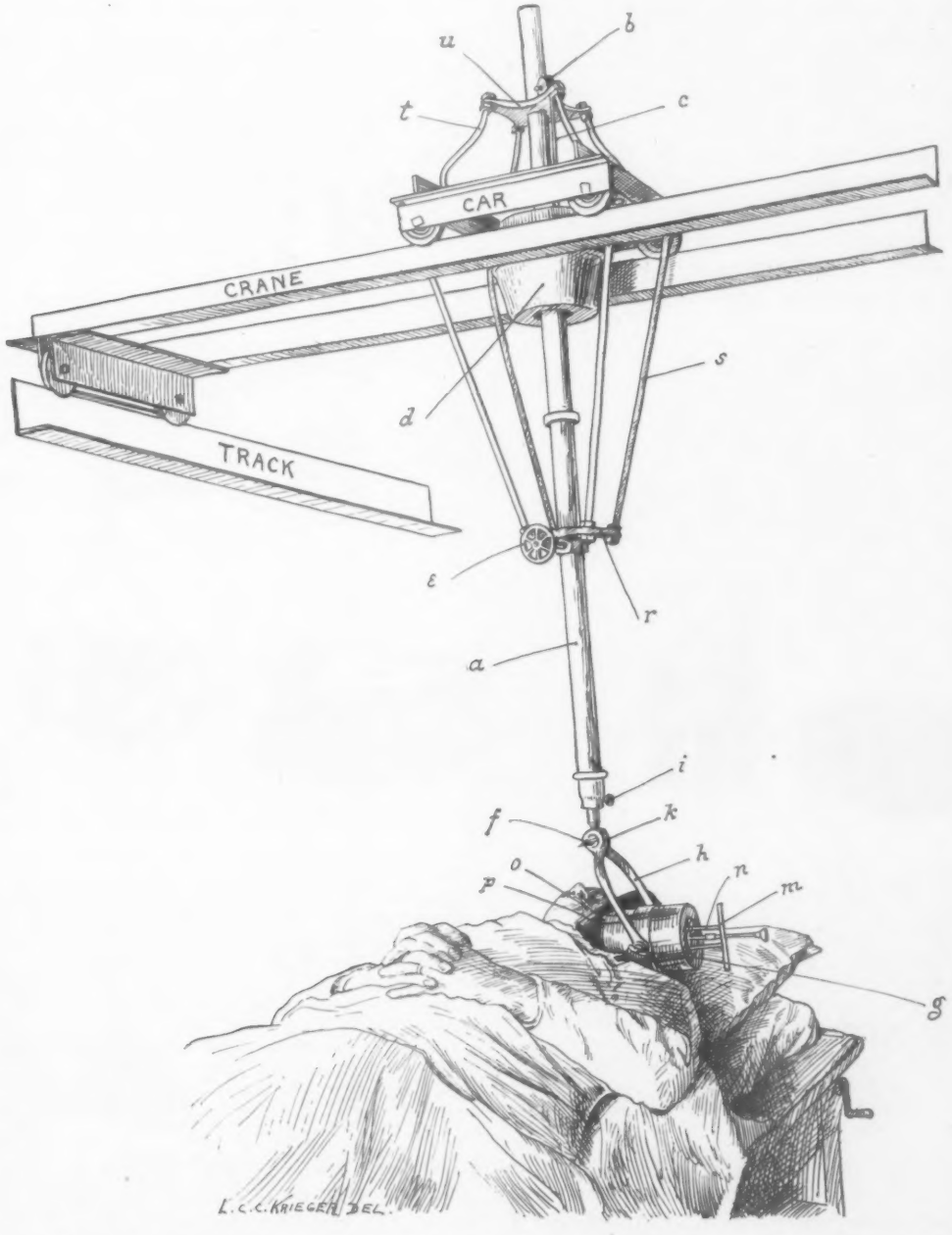

FIG. 2. Suspension apparatus and cylinder "set up" as in the treatment of a parotid tumor; (*a*) shaft; (*b*) pulley carrying cable (*c*) which suspends shaft and counterbalances weight (*d*); (*e*) safety hand-screw; (*f*, *g* and *i*) thumbscrews for adjusting cylinder; (*k*) cogs preventing bail (*b*) from slipping; (*n*) scale on handle (*m*) of radium carrier; (*o*) aluminum filter cap; (*p*) sheet rubber filter; (*s* and *t*) braces ending in brass plates (*u* and *r*) which prevent any swaying of shaft.

penetrates, the wider it grows and the more certain it is to cover all the disease. Further studies will be issued as completed.

Following the introduction of our lead cylinders we noticed the striking fact that the same dosage we had been using in like cases with the plain package now caused a marked erythema in some 80 per

cent, sometimes even amounting to blistering, an obviously undesirable reaction. The irritation was not like an overdose of gamma rays, but came from two or three days to as late as five weeks after the treatment and lasted from a few days to six weeks. (This has been a matter of careful statistical research.) We thought at first that it was due to "K radiations" from the lead (that is to say, specific for lead) or possibly to some excited secondary beta radiations. To obviate this we first tried placing two to four layers of thin rubber between the orifice of the cylinder and the skin, and failed; 2 mm. of aluminum were then added to the rubber, and since that time we have had no more of the irritation. The aluminum absorbs the secondary rays from the lead and the rubber the secondary rays from the aluminum and we are quit of them. These aluminum protectors are thin discs 1 mm. in thickness, cut to fit the size and shape of the end of each cylinder applicator nearest the skin. The one at D, Figure 4, is for the 2-in. cylinder, and the one at C, Figure 3, is curved to fit the end of the cylinder B of the same figure.

At D, Figure 3, are shown several circular applicators of a different type; these are used when it is not necessary to guard so carefully against scattering, but when some lead protection is advisable, and also in treating with the portable suspension table (described later). This set of applicators consists of a series of four rings, each 2 in. high and fitting one inside the other as shown. In the figure one is raised above another to demonstrate the construction. The portals are 1, 2, 3 and 4 in. in diameter. In setting up the apparatus the desired portal is chosen and the box containing the radium emanation is placed on an adhesive tape strapped across the top of the portal. The rings are shown in the car made to carry them (see description of portable suspension table, Fig. 6).

In using such heavy applicators, the question immediately arises as to the

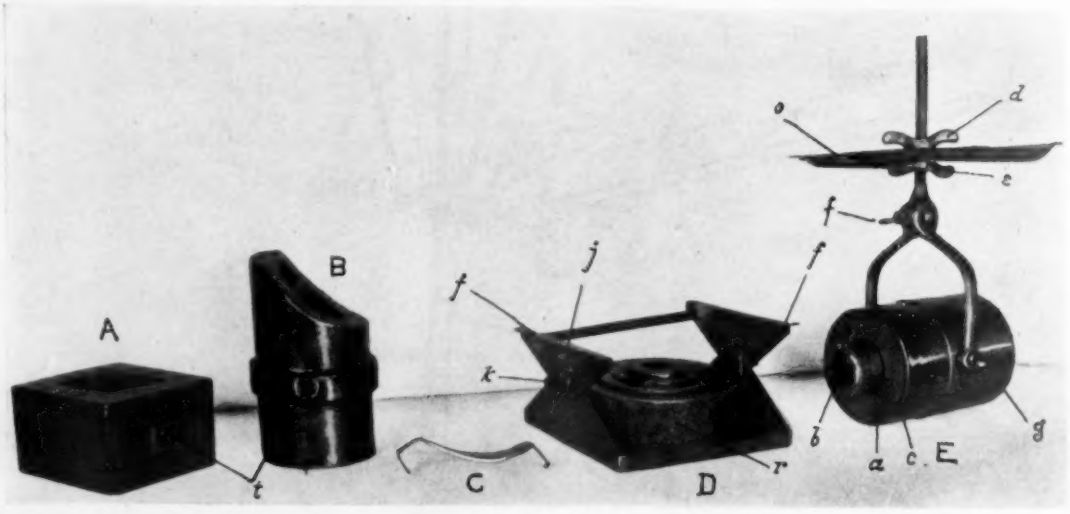

FIG. 3. A, "square cylinder." The advantage here is that in treating adjacent areas the square portals leave no portion of the tumors unradiated: (*t*) holes for thumbscrews which hold cylinder in suspension apparatus. B, a cylinder with proximal end cut to fit curved surface of the skull. This was used in treating an inoperable brain tumor from five angles without overlapping. C, aluminum filter; cap curved to fit cylinder B. D, set of treatment rings shown in the car which carries them and which runs on the track of the portable suspension table shown in Figure 6; (*r*) lead rings; (*f*) flanges to fit tracks; (*j*) thumbscrew which tightens against track and serves as brake on the car; (*k*) thumbscrew adjusting angle of the car and rings with the skin. E, 2-in. cylinder with adjusting apparatus as used with the portable suspension table shown in Figure 6. In the figure a longer cylinder (*b*) with a 1-in. portal is seen projecting from the 2-in. portal of the larger and shorter cylinder. Such a device is used in treating glands situated in difficult places, as beneath the jaw, etc.; (*a*) wall of 2-in. cylinder made of 1 in. of lead. (*c*) $\frac{1}{8}$ in. brass reinforcing lead; (*f* and *g*) thumbscrews for adjusting cylinder to any angle with the skin; (*o*) car for portable suspension table seen in Figure 6; (*d* and *e*) wing nuts for adjusting height of cylinder.

mechanism of handling and support. Several ideas were suggested, but the one which seemed the most efficient and ratus shown in Figure 2. (We owe much to the cooperation of Dr. Fred West of our staff and to Messrs. Nicholson and

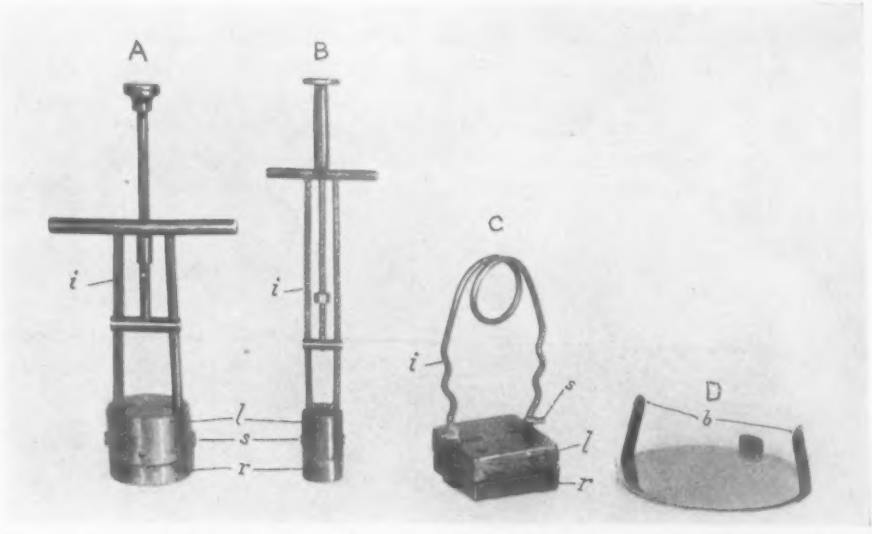

FIG. 4. A, emanation carrier for 2-in. cylinder; B, emanation carrier for 1-in. cylinder; C, emanation carrier for "square cylinder"; (*l*) 1 in. of lead in cover of carrier (in square carrier C it is ½ in. in thickness); (r) emanation container made of hard rubber reinforced with brass (no brass on bottom so that filtration is only through a thin layer of rubber); (*s*) brass stubs so arranged that movements of the cross-bar of the handle upwards force them against the inner wall of the cylinder, thus fixing the carrier at the desired point. In C the spring of the handle serves to force stubs against wall of the cylinder; (*i*) scale in inches indicating distance of radium emanation from mouth of the cylinder; D, aluminum filter-cap for 2-in. cylinder. This slips easily over proximal end of the cylinder and is held in place by brass springs (*b*) at the sides.

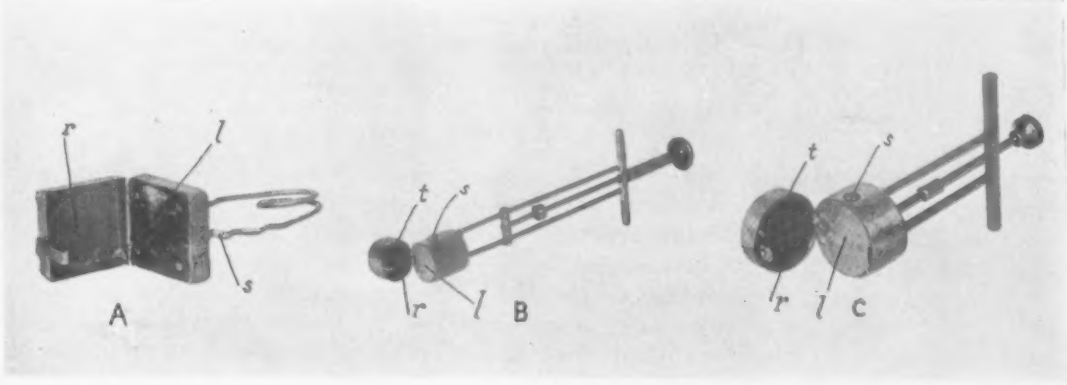

FIG. 5. B and C, emanation carriers for the 1-in. and 2-in. cylinders respectively; open to show pockets (*t*) for emanation tubes (*s*, *l* and *r*) as in Figure A, emanation carrier for square cylinder, open to show plain brass box (*r*) without separate holes for each tube. This is used when our emanation tubes are of variable size, as when several special-size tubes are made for a specific treatment and later used in the composite package of emanation.

permitted of all movements, so that focusing in any direction and on any tumor would be easy, was the suspension appa- Johnson, mechanics, for help in devising the suspension apparatus, as well as the treatment table and mechanical achieve-

ments of the cylinder. Their skilled workmanship has made these appliances possible.)

The suspension apparatus is briefly as follows: A firm track of 4-in. angle iron carrying a fairly long crane is built in the room. The crane supports a car 18 in. square and made of 2-in. angle iron. The cylinders are suspended from the car by means of a shaft (*a*) of 1½-in. pipe swung on two cables (*c*) running over two pulleys (*b*) at the top and fastened to a weight (*d*) which counter-balances the cylinder. In this manner a vertical movement of 22 in. may be given to the cylinder without necessitating actual lifting. A safety hand-screw (*e*) is placed in the lower end of the car, which, when tight, prevents any vertical movement of the shaft, thereby assuring a firm position when set up and at the same time guarding against accident if the cable should break. A series of thumb-screws allows all movements necessary to focus at any point on the body. With this suspension all weight is taken off the patient, who is thus able to lie comfortably for several hours. It is often impossible or inexpedient to bring a patient to the treatment room. Accordingly, a portable suspension table (referred to above) is used, the patient remaining in his own bed. This apparatus, illustrated in Figure 6, carried any type of cylinder as well as the concentric rings. In the illustration the largest ring and a 2-in. cylinder are shown in place, although of course, only one is used at a time when treating.

For further protection to workers, and for further facilitating giving various treatments, C. F. Burnam devised the treatment table shown in Figure 7, made of wood and measuring 6 ft., 8 in. in length, and 2 ft., 11 in. in width, and standing 2 ft., 8 in. high. The top is smooth except for a ½-in. ridge around the edge to hold the mattress on. The protective feature of this table consists of a lead block 1 in. thick and 18 in. square beneath the top of the table and carried by a car running on track and crane. By means of rope, pulleys and crank, and handles projecting down from the car, as indicated in the figure, and reproduced in the cut, this lead block may be placed directly in line of fire of the rays from the charge of radium emanation in the cylinder, thereby absorbing the

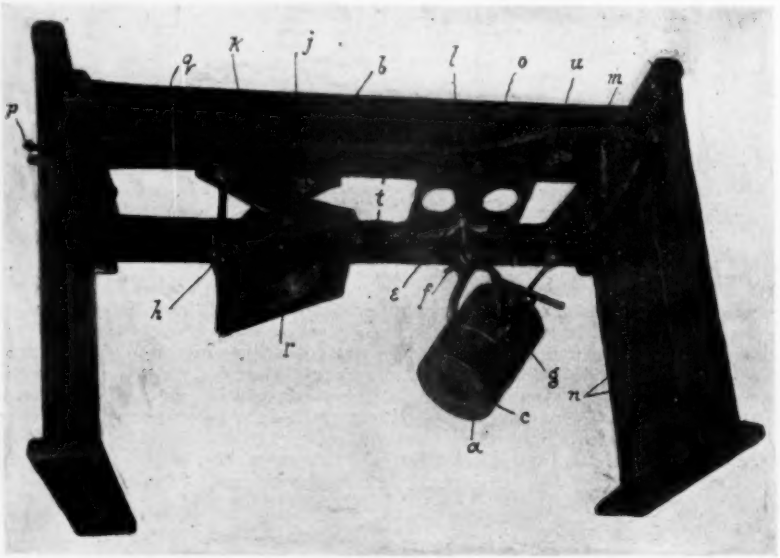

FIG. 6. Portable suspension table; (*n*) two vertical slots in end of the table through which pass bolts from adjustable top (*b*) allowing it to be fixed at any desired height by tightening thumbscrew (*p*); (*t*) track; (*b* and *o*) cars. One track is pivoted at (*q*), the end (*m*) being movable so that, by spreading, the cars may be taken off or put on; (*u*) thumbscrew for tightening movable end of track. (*l*) brake for car (*o*) thumbscrew removed. Other lettering as in D and E, Figure 3.

rays and safeguarding those in the room below. This may seem unnecessary at first, but when we recall the sad experience of the fogging of seventy-five dollars' worth of photographic plates in a room obliquely below the one in which radium treatments were given, the caution is clearly justified. A glance at the figure shows a two-piece mattress, the upper and larger part measuring 2 by 4 ft. and the lower and smaller one 2 ft. square, the mattress is now put under the legs, the handle of the radium applicator being strapped securely to sandbags. In this manner lifting and tugging at the patient with the consequent danger of dislodging the radium applicator are avoided and the treatment is affected quietly and easily.

SUMMARY

1. Great emphasis must be placed on thorough protection in using radium in

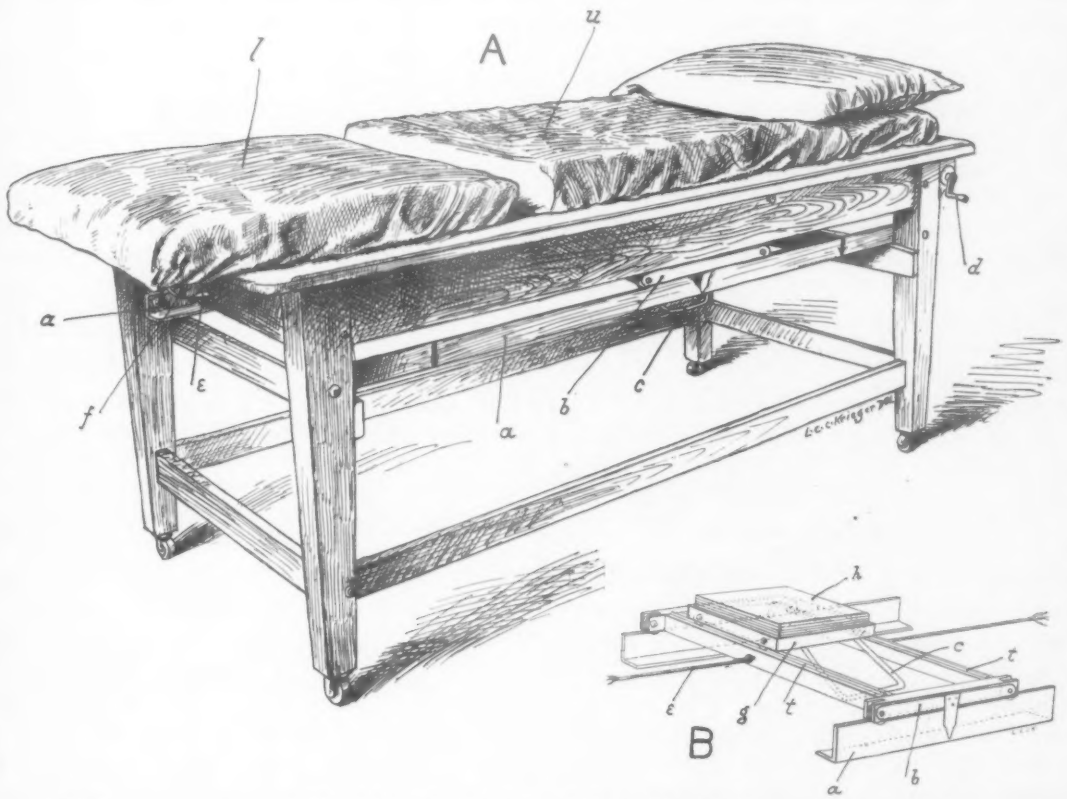

FIG. 7. A, Burnam treatment table. (*a*) track of 2-in. angle iron; (*b*) end of crane with arrow indicating center; (*c*) handle for moving car; (*d*, *e* and *f*) crank, rope and pulley respectively, used for moving crane. (*l* and *u*) lower and upper mattresses respectively, separated to show construction. B, Insert showing crane (*b*) and car (*g*) carrying 1-in. lead block (*h*) 18 in. square; (*t*) tracks on crane for car (*g*); (*c*, *e* and *a*) as in A.

purpose being to facilitate cervical, intrauterine, rectal and other treatments requiring a change from the perineal to the dorsal posture. In such cases the lower mattress is removed and the upper one brought to the foot of the table. The patient is put in the perineal position, and the treatment applied, with or without anesthesia, after which the upper mattress is pulled back into place, bringing the patient completely on the table. The lower

therapeutics. The following essential features must be borne in mind in choosing efficient apparatus for heavy treatments.

(*a*) It must prevent as far as possible all radiation of the patient except at the site of the disease.

(*b*) It must permit of cross-firing at deep tumors without over-lapping. An example of this may be seen in the treatment of rectal carcinoma where, by the use of these cylinders, we frequently give 10 gm.

hours radiation at a 3-in. distance over six areas. These areas are chosen over sacrum, perineum and abdomen. Taking the distance from the skin to the growth as being on an average of 2½ in. we see that the total dose would be 60 gm. hours at 5 in. distance, or more than 2 gm. hours direct, and at the same time we are radiating any metastatic growth in the pelvis.

(*c*) It must be capable of being made absolutely immobile after it is once "set up," so that the operator will be confident that when he leaves the room the nurse can easily place the charge without dislodging the apparatus.

(*d*) It must be easy and accurate of manipulation without exposure of the operator.

(*e*) It must be comfortable for the patient.

(*f*) It must limit as far as possible exposure to nurses handling the emanation.

These criteria we claim are met in the cylinders and the suspension apparatus above described.

2. We wish to encourage the use of aluminum and rubber as efficient filters to absorb soft, secondary radiation when using lead protection in radium therapy. (In treating growths in the mouth, vagina and other cavities, the gauze in which the lead filters are wrapped absorbs the soft secondary rays from the lead.)

3. With the use of the treatment table we can greatly facilitate our heavy external treatments and our intrauterine and other treatments requiring a change of posture from the perineal to the dorsal, at the same time affording an added protection to those in the rooms below the one in which the treatment is being given.

THE RESISTANCE OF THE THYROID GLAND TO THE ACTION OF RADIUM RAYS. THE RESULTS OF EXPERIMENTAL IMPLANTATION OF RADIUM NEEDLES IN THE THYROID OF DOGS*

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THE following work was undertaken to determine the effect of radium rays on normal thyroid tissue. The results, we feel, will be of interest to the radiologist, for they seem to emphasize that the type of tissue radiated is of equal importance to the dosage.

Abbe[1] in 1904, reported a case of exophthalmic goiter in which a capsule containing 10 cgm. of Curie radium (300,000 activity) was inserted in the hypertrophied middle lobe and allowed to remain *in situ* for twenty-four hours. Four months later, the patient felt subjectively well, although a slight tachycardia was still present. The circumference of the neck had diminished 1½ in. and the thyroid seemed to be about ⅙ its former size. Burrows[2] in 1918, reported 79 cases of exophthalmic goiter treated by radium; 2 with implantations, 75 with surface applications. One with implantation of tubes did not return for re-examination, but the other showed considerable diminution in the size of the gland and improvement in symptoms. Aikins[3] in 1916, had treated 45 cases with surface applications and in 1920,[4] reported a total of 100 so treated. Clagett[5] in 1920, reported 31 cases in which surface applications of radium had been used. Terry[6] in 1921, implanted emanation tubes in 11 cases and in 1922,[7] reported 22 additional ones.

While the reports from these authors were in all instances favorable, the technique of application and the dosage varied very markedly. Abbe[1] implanted 100 mg. of unscreened radium for twenty-four hours (2,400 mg. hrs.). Aikins[4] screened the beta rays and employed a primary

* Preliminary report read before the Section of Experimental Surgery, American College of Surgeons, Philadelphia, Pa., October, 1921.

treatment of 150–360 mg. hrs., and subsequent treatments of 50–150 mg. hrs. Clagett[5] obtained symptomatic cure using 50 mg. hrs. of radium screened by silver, brass and rubber. Later he applied 100 mg. of radium filtered through lead, rubber and platinum for from 6–12 hrs. (600–1200 mg. hrs.). With the exception of Terry[7] none of these authors reported the histologic changes in the thyroid following radiation, nor have we found any reference in the literature to the changes produced by radium in the normal thyroid.

Dogs were used in the experiments because of the size of the thyroid glands and because histologically they are almost identical to those in man. Implantation of radium needles was chosen as the best method of determining the changes produced, since the effects of different dosages could be accurately noted, and there would be no chance of the needles slipping, which might occur if surface applications were employed. Needles containing 12.5 mg. of radium were used throughout the experiments. A steel needle, of the same size as that containing the radium, was used as a control. Both were threaded with silk and sterilized by placing in 95 per cent alcohol for twenty minutes. The dogs were etherized, the necks shaved and painted with tincture of iodine. The glands, lying one on either side of the trachea, just below the thyroid cartilage, were exposed through a mid-line incision and separation of the neck muscles. The thyroid was freed from the surrounding loose areolar tissue by blunt dissection, care being taken not to injure the blood supply entering the gland at the inferior pole. The glands were very resistant and tough, so a cataract knife was used as an obturator, as this produced less trauma than the attempt at forceful introduction of the needle alone. Both radium and control needles were inserted into the thyroid at the inferior pole as near the center as possible; the glands were then allowed to slip back in place and the silk strings brought to the lower end of the incision and coiled up between the fascia and the skin. Both fascia and skin were closed with interrupted silk sutures. After varying periods of time, the dogs were again anesthetized, a few of the sutures removed and the needles drawn out by gentle traction. The wounds were closed without drainage. With the exception of one stitch abscess in Dog No. 2, all wounds healed by primary union. The animals, with the exception of two, showed no ill effects from the operation or from the loss of thyroid tissue, which was small in all cases. Dog No. 7, operated on in the heat of midsummer, was extremely sick and prostrated, although the wound was clean. In Dog No. 13, the radiated gland had diminished to one-quarter the size of the control gland, while the dog had increased in weight and had become less active. They were killed at the expiration of a specified time (Chart I). The glands were weighed, hardened in salt solution containing 4 per cent formalin, sectioned and stained by the routine method (haemotoxylin and eosin) and Mallory's connective tissue stain.

In all, 15 dogs were employed. The needles remained in the thyroid from 2 to 13½ hours. The glands were removed at the end of 7, 10, 14, 21, 28, 68, 73, 75, 84, and 210 days. The results can be briefly summarized as follows:

RESULTS

The portion of the gland affected by the radium showed grossly as a yellowish area surrounded by a narrow reddish band. The size varied with the length of time the radium acted, but not in direct proportion. In Dog No. 1, 25 mg. hrs. produced a lesion 1 × 2 mm. in diameter; Dog No. 3, following 50 mg. hrs., showed an area of destruction 2 × 4 mm., while in Dog No. 5, an exposure of 112 mg. hrs. destroyed only an area 4 × 3 mm. in diameter.

The destructive action of the radium persisted to about the beginning of the third week, with an increase in the weight of the gland as compared to the weight of the opposite lobe; after that, organization and healing began and the weight diminished. Prior to the third week, the essential histologic change was one of necrosis and hemorrhage. The necrosis was confined to the central portion of the affected area and appeared as an amorphous

material, in which all structural elements were lost, even the blood-vessels. This area of complete necrosis merged almost imperceptibly into a peripheral zone of necrosis, resembling the microscopic picture of an early infarct, in which shadows of former acini and remains of blood-vessels could be distinguished. Scattered throughout were fibrin and red blood-cells. The outer border of this zone contained many fragmented nuclei, lymphocytes, a few plasma cells and an occasional polymorphonuclear leucocyte. Immediately peripheral to this was a narrow zone of hemorrhage, lying in a tissue architecturally distorted, but showing only slight degenerative histologic changes.

Segments of acini remained, showing swollen cuboidal epithelium with deeply staining nuclei. Other acini were intact but much shrunken. Colloid was scant or entirely lacking and the vesicles contained

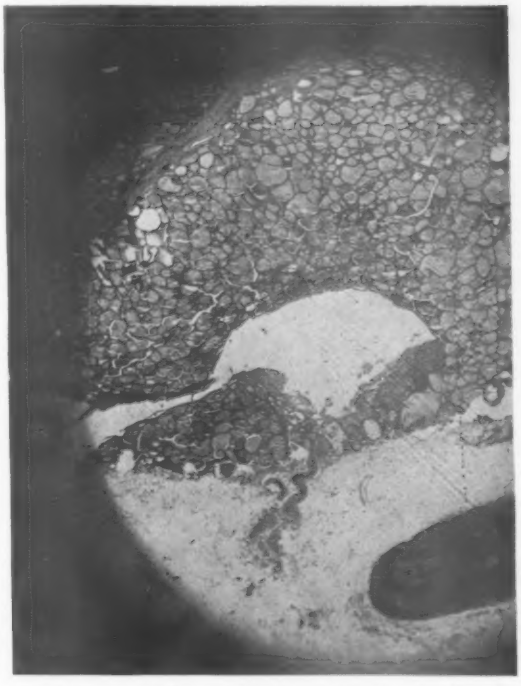
CHART I

Dog	Date of Operation	Control	Mg. Hrs. Radium	Glands Removed	Weight Radiated Gland, Gm.	Weight Control Gland, Gm.	Area of Destruction, Mm.	Weight Dog, Kilo.	Remarks
I	4/22/21	Steel needle	25	10th day	1.39	1.34	1.0×2.0	14.8	
II	4/29/21	Steel needle	25	14th day	0.755	0.715	1.0×2.0	14.0	
III	5/ 3/21	Steel needle	50	14th day	1.29	1.13	2.0×4.0	13.6	
IV	5/ 5/21	Dog used as control to compare weight of glands. One weighed 1.93 gm.; the other 2.09							
V	5/10/21	0.3 c.c. quinine urea hydrochloride	112	14th day	0.84	0.61	4.0×3.0	14.6	Control gland small, indurated and densely adherent
VI	6/22/21	Steel needle	100	70th day	0.69	0.780	4.0×3.0	9.7	
VII	6/24/21	0.3 c.c. quinine urea hydrochloride	112	21st day	1.025	1.592	2.0×2.0	14.3	Dog prostrated, wound clean, hemorrhage around control gland
VIII	6/24/21	0.3 c.c. boiling water	106	28th day	0.935	1.273	2.5×3.0	15.0	
IX	7/16/21	Steel needle	100	84th day	0.475	0.840	3.0×2.0	11.8	Radiated gland appeared pale and bloodless: calcification
X	3/11/22	Steel needle	125	73d day	0.197	0.215	3.5×2.5	11.3	
XI	3/16/22	Steel needle	150	68th day	0.325	0.695	4.0×2.5	14.0	
XII	3/30/22	Steel needle	168	75th day	.....	.....	4.0×5.5	....	Radiated gland pale: calcification
XIII	5/ 4/22	Steel needle	150	210th day	0.16	0.735	1.0×0.5	....	Gland extremely small and pale

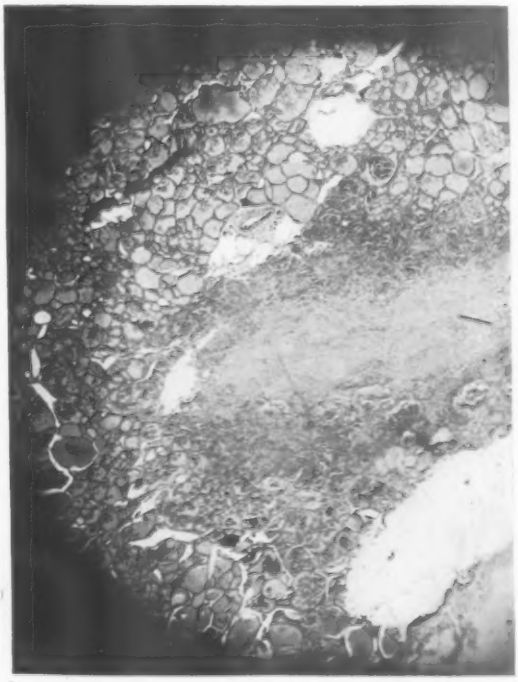
CHART II

Dog	Amount Radium Used, Mg.	Screen	Date Inserted	Date Removed	Mg. Hours	Tissue Excised	Area Destroyed, Mm.	Remarks
XIV	50	1 mm. brass	4/20/22	4/21/22	1200	4/26/22	13×16	Dog in good health when killed
XV	50	1 mm. brass	4/27/22	4/28/22	1200	5/ 8/22	16×19	Dog survived partial pancreatectomy, dying in December, 1922, in an emaciated condition. At autopsy no remnants of pancreas could be found

Dog I. 25 mg. hrs. Gland removed 10th day.



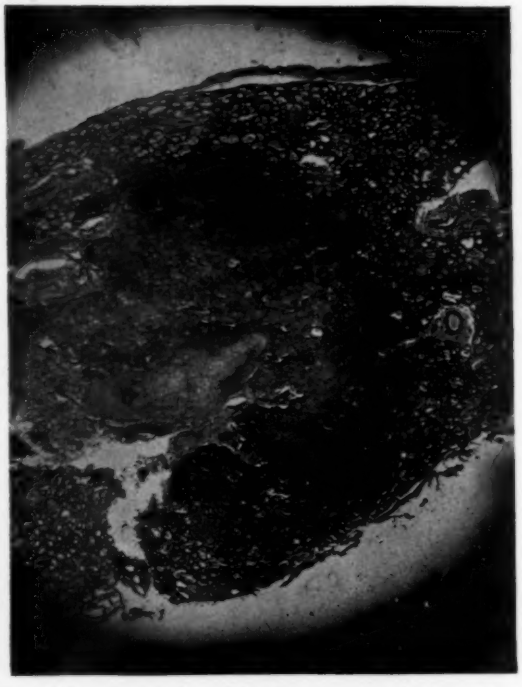
Dog II. 25 mg. hrs. Gland removed 14th day. Note sharp line of demarcation between normal tissue and destroyed area.



Dog III. 50 mg. hrs. Gland removed 14th day.

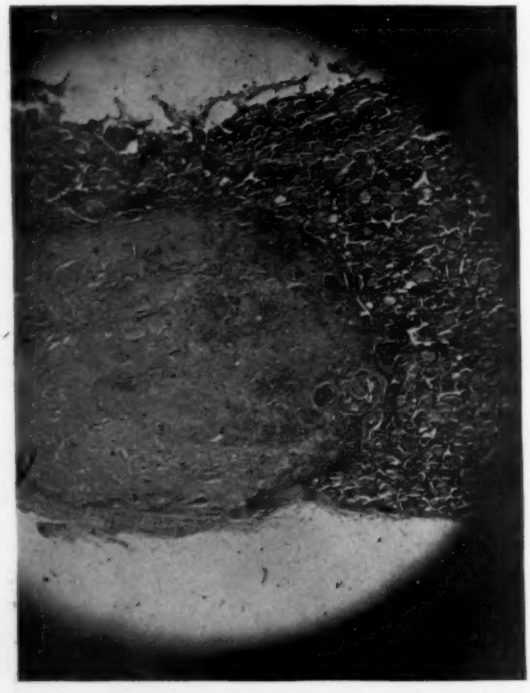
Dog V. 112 mg. hrs. Gland removed 14th day. Note increased area of necrosis compared to Dog III.

FIG. 1. Effect of varying exposures of the thyroid of dogs to raduim.

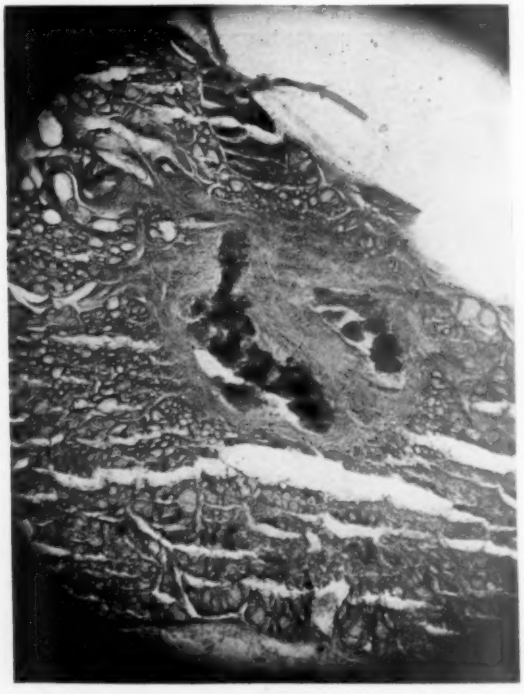


Dog VI. 100 mg. hrs. Gland removed 7th day. Note wide zone of hemorrhage.

Dog VII. 112 mg. hrs. Gland removed 21st day.



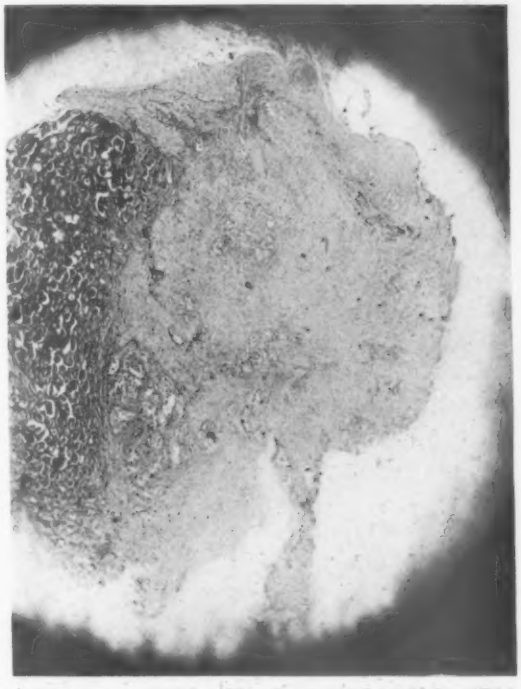
Dog VIII. 106 mg. hrs. Gland removed 28th day. Note sharp line of demarcation between healthy and necrotic tissue.



Dog IX. 100 mg. hrs. Gland removed 84th day. Note areas of calcification.

FIG. 2. Effect of radium on thyroids removed at varying periods of time. Mg. hrs. exposure practically identical.

Dog X. 125 mg. hrs. Gland removed 73rd day.



Dog XI. 150 mg. hrs. Gland removed 68th day. Compare with dog IX.

Dog XII. 168 mg. hrs. Gland removed 77th day. Calcification present.

Dog XIII. 150 mg. hrs. Gland removed 210th day.

FIG. 3. Effect of increased dosage on thyroid of dogs.

FIG. 4. Effect of steel needle in thyroid for 8 hrs. Gland removed 7th day.

FIG. 5. Effect of 0.3 c.c. of 0.3 per cent quinine and urea hydrochloride. Gland removed 14th day.

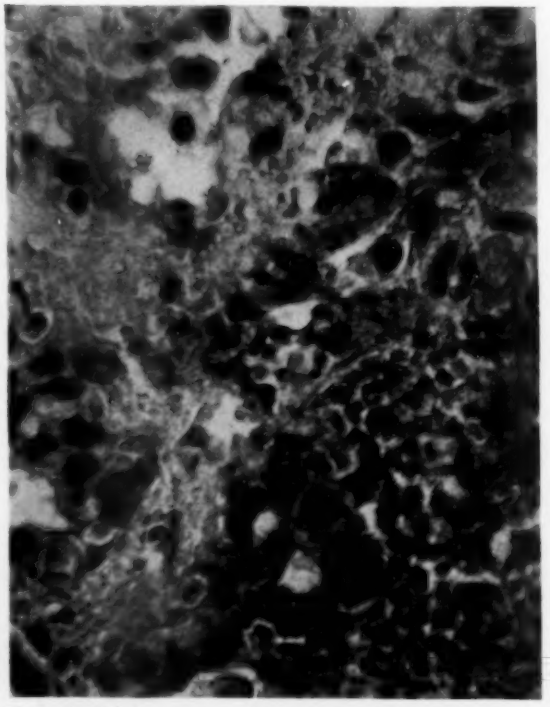


FIG. 6. High power photomicrograph of border of affected area in thyroid. Note hyperchromatic nuclei and mononuclear cell infiltration.

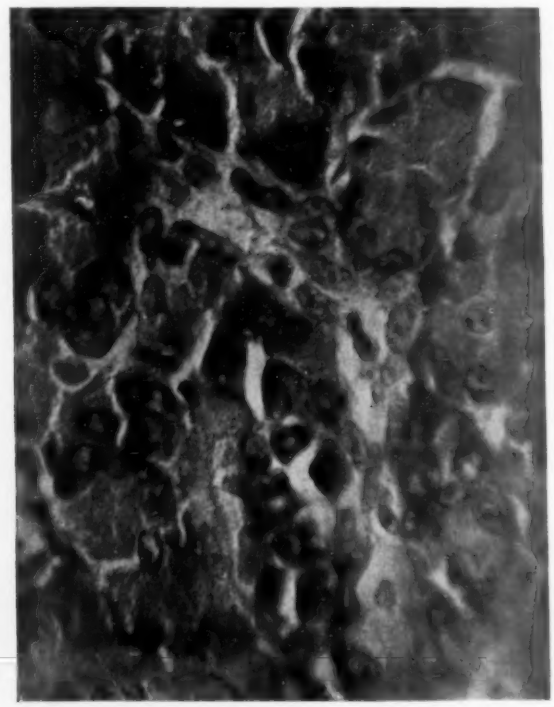


FIG. 7. High power photomicrograph of pancreas well beyond area of necrosis produced by radium. Most nuclei show hyperchromatism, although some exhibit poor staining qualities. In many the nucleolus alone remains, surrounded by a nuclear membrane.

many red blood-cells and occasional degenerated vacuolated large mononuclear phagocytes. Beyond this, the acini appeared normal. They were lined by a flattened cuboidal epithelium, resembling that at the periphery of the gland, and showed no degenerative changes in either nuclei or cytoplasm. They were filled with colloid material of almost the same density as that at a distance, although occasional red blood-cells and phagocytes were present. The thyroid vesicles, distant from the zone of hemorrhage about the depth of two acini, were normal as far as we could determine by ordinary staining methods. The degenerative changes in the nuclei of epithelial cells, namely the vacuolization and apparent dropping out of the nuclear material, so often found in radiated malignant tissue, were not noted, nor was any constant change observed in the blood-vessels as reported by Williamson, Brown and Butler[8] in their work on the brain of dogs.

About the third week, organization and healing began by a proliferation of fibroblasts from the periphery. The necrotic material was partially removed by phagocytosis and was replaced by connective tissue with a deposition of lime salts in two cases. A few blood-vessels became occluded by a subintimal proliferation of fibrous tissue. Again cells beyond the zone of repair showed no nuclear or cytoplasmic changes. No change was observed in the parathyroid glands.

The effect of radium compared with that produced by quinine and urea hydrochloride and boiling water injections was striking. Boiling water produced no demonstrable microscopic lesion at the end of one month. In the two cases in which quinine and urea hydrochloride was used, the amount of destruction was microscopic only, consisting of a loss of colloid in two or three acini, with granular swelling of the epithelial cells and infiltration with plasma cells. This may be due to the small amount of solution used, 0.3 c.c., because large areas of necrosis are encountered in the thyroid of man following this treatment. In addition, the glands so treated were rather densely adherent to the surrounding tissue, similar to cases of exophthalmic goiter treated by *x*-ray in man, while glands treated by radium were in all instances free from adhesions. Terry[7] has drawn attention to this freedom from adhesions following implantation of radium emanation tubes.

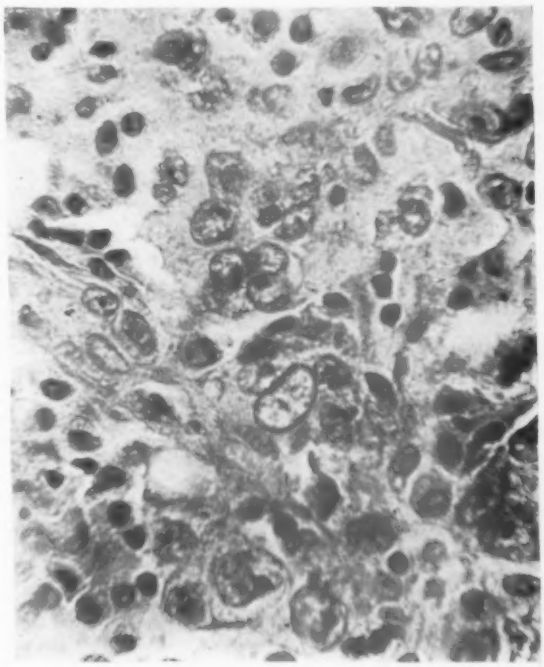


FIG. 8. Section of metastatic carcinomatous lymph-gland 0.5 cm. from needle insert. Note open vacuolated nuclei, some showing a nucleolus, others simply a nuclear membrane.

DISCUSSION

Richards[9] states that the effects of radium are due to (1) the strength of the radium, (2) the duration of exposure, (3) the distance of the object (or tissue) from the source of radiation. To these we may add (4) the type of tissue or tumor, for it is well known that different types of tissue, and consequently different types of cells, react differently to radiation. Ewing,[10] in discussing the factors influencing the results of radium therapy states that "one of the most prominent of these questions concerns the relation of the structure of tumor or tissue to the reaction of radium." Schmitz[11] says that the type of cell is most important. Epithelial cells are more receptive to radium—to use the term of Dominici—than the connective-

tissue cells. Bergonié and Tribondeau state that immature cells and cells in an active state of division are more sensitive to the rays than cells that have already acquired adult fixed morphologic or physiologic characteristics. The basal cells of hair follicles and the epidermis, lymphoid cells, ova and spermatozoa are readily killed by an amount of rays which leave intact the surrounding mature cells. Schmitz[12] says the nearer the cells are embryonal in type, the more receptive they are to rays and undergo more readily cytolysis and destruction. Colwell and Russ[13] state that very rapidly growing cells are most affected by radium. Ewing[10] confirms this by saying that "tumors responding most readily to the simplest test of therapeutic efficiency and diminution in size are usually cellular and rapidly growing tumors."

Not only is the type of cell composing the tissue or tumor important in considering the reaction to radium, but also the structure of the tissue itself. Quite early in the treatment of malignant tumors by radium, it was recognized that certain types of tumors responded very readily to radium rays, while others were refractory. Hanford[14] states that marked improvement may be expected in carcinoma of the breast recurring after operation. Ewing[10] had explained this by saying: "Early and rapidly growing metastases of mammary carcinoma may often respond readily to radium, whereas older tumors which have become fibrous may show very little or no reduction in size after persistent radiation." Schmitz[11] classes the radiosensitive tumors as epidermoid and basal-cell epithelioma, lymphosarcoma from embryonal lymph-cells; sarcomata from embryonal connective tissue cells in which connective tissue fibrillæ, cartilaginous and osseous tissue have undergone absorption; fibromata in which fibroblasts are present in large numbers and do not develop into adult cells. Janeway[15] considers the clearest example of the selective action of radium on tumor tissue to be furnished by the cellular teratoma and lymphosarcoma which "seem to melt away with the greatest rapidity, whenever, one might almost say, radium is anywhere in their vicinity." Ewing[16] has obtained retrogression of deep-seated tumors, particularly mediastinal lymphosarcoma, carcinoma of the lung and abdominal metastases from carcinoma of the testes, after massive doses of radium. Although Simpson,[17] in his chapter on Intratumoral Radiation, makes no mention of the histologic character of the growth, Ewing[10] feels that not only is the type of tumor tissue important, but also the stage in its growth when treated, for "very striking differences are often observed in the reaction of recent as compared with old tumors of Hodgkin's granuloma malignum, and this difference accords with the natural change of structure, the older tumor becoming fibrous." In this same article he indicates the types of tumor reactive to radium treatment and those that are resistant. The majority of authors agree that squamous-cell epithelioma, whether skin or cervix, is resistant to the action of radium (Hanford,[14] Schmitz,[11] Ewing[10]). Wood[18] states that basal-cell carcinoma containing keratin resists radium, but is uncertain whether the keratin is the resisting substance or is a result of radium treatment, for the sections of the tumor were examined after radiation. Chondroma is supposed to be refractory to radium, but will respond satisfactorily if one will take sufficient time for treatment (Ewing[10]). Fibrosarcoma, particularly of the spindle-cell variety is considered resistant to radium, says Schmitz[11] and Ewing,[10] as are also fibroma containing atrophic fibroblasts and much connective tissue (Schmitz[11]). Ewing[16] feels that radium may change a malignant into a relatively benign tumor; while Bumpus[19] shows that massive doses of radium in carcinoma of the prostate produced marked proliferation of fibrous bands. He states: "These malignant cells are atypical in appearance, being pressed and squeezed into distorted shapes by an ever-increasing proliferation of connective tissue cells. The reproductive function of the malignant cells is undoubtedly impaired and if all malignant tissue can be thus affected, complete cessation of the process must occur."

These remarks, we hope, will indicate the importance of considering not only the type of cell composing the tissue, but also

the architectural structure of that tissue, when endeavoring to determine the effect of radium.

In addition to histologic structure, one must consider the physiological characteristics of a tissue in studying the effect of radium rays. Prime[20] showed that there was "great difference in the quantity of radium required to kill the physically functioning cells, such as heart muscle, and a merely growing cell, such as is found in connective tissue or in malignant tumors." He felt that radium did not kill the cell outright, but injured the nucleus in such a manner as to prevent further division, which must eventually result in the death of the cell. In experimenting with mouse cancer, von Wassermann[21] found that after exposure to radium the cells remained alive, but did not take; and he concluded that the genuceptors were killed. The Hertwigs[22] advanced the hypothesis that the effect of radium was a direct one on the chromatin of the nucleus. Schwarz[23] thought that radium decomposed the lecithin (present in all cells and particularly rapidly growing ones) into cholin and trimethylamine and that the action of radium was due to the liberated cholin. Gager, quoted by Richards[9] concluded from a review of the literature in 1908, that radium seemed to retard the activity of the enzymes, although Löwenthal and Edelstein[24] in the same year found increased autolysis after exposure to radium emanation. This varied markedly with the character of the material subjected to autolysis; the most marked increase occurring in human cancer. Packard[25] suggested that radium radiations act indirectly on the chromatin and protoplasm by activating autolytic enzymes, which bring about a degeneration of the complex proteins, and probably by affecting other protoplasmic processes in the same manner. Richards and Woodward[26] found that weak radiation increased enzyme activity and strong inhibited it; and Richards[9] concluded that the modifiability of enzymes played an important part in radium effects, although the chromatin changes were undoubtedly important. Pendergrass *et al*[27] offered as a working hypothesis of the action of radiation on living tissue "that it is due to a primary effect upon the nucleus and the resultant death of the cell under conditions favoring autolysis."

Based on the modification of enzyme activity, it was argued that a tissue rich in ferments should theoretically show greater effects from radiation than one poor in ferments. Histologically, the thyroid is composed of closed follicles, lined by a flattened cuboidal epithelium, embedded in a rather compact connective tissue stroma. So far as is known, the thyroid produces no known ferment. In contrast to the thyroid is the pancreas, enclosing, in a light stroma of connective tissue, abundant glandular epithelium, which manufactures three strong ferments. It was deemed of interest to note the effect of radium on the pancreas. The accompanying Chart II shows the results obtained in two experiments.

REMARKS

In studying the effect of radium on the normal thyroid tissue, the most striking feature observed was the apparent resistance to the rays. In all glands examined, there was an abrupt line of demarcation between destroyed and healthy tissue. Only the cells immediately surrounding the necrotic area showed degenerative changes. Beyond this and almost immediately, the epithelial cells appeared normal in every respect. Terry[7] noted this fact and states: "The transition from complete necrosis to undamaged tissue is sharp." Lacassagne[28] buried radium emanation tubes in the muscles of rabbits, and also found a sharp line of demarcation between necrotic and apparently healthy tissue.

Bumpus,[19] in an adenocarcinoma of the prostate treated thirty-one days before death with 700 mg. hrs. of radium, showed that a limited area was affected by the large dosage. Photomicrographs of areas beyond the influence of the radium showed active viable cells exhibiting mitosis; but sections taken close to the area affected by radium showed loss of cell outline, poor staining qualities and fragments of destroyed cells. Quick[29] has noted hydropic degeneration, necrosis, shrinkage and nuclear pycnosis in carcinoma of the breast forty-nine days after implantation of

radium emanation tubes. Bagg[30] experimented with buried emanation tubes in Flexner Jobling rat carcinoma, after a successful take. Tumors 1 cm. in diameter showed irregular areas of necrosis seven days after burying a tube containing 0.3 mc. The outlying cells showed marked hypertrophy and hyperchromatism of the nuclei, while the cell bodies were large and hydropic. He felt that radiation was effective for a distance of 1 cm., similar to the reaction in normal tissue.

Colwell and Russ[13] noted in tissue exposed to hard beta and gamma rays, a primary serous infiltration with enlargement of the cell nucleus and body; a swelling of the endothelial cells of the capillaries with a decrease in the size of the lumen. In seven to eight days there was degeneration of the cell nucleus, cessation of mitosis, pycnosis, cytolysis and achromatism. The cytoplasm exhibited vacuolation and granulation. The reaction was an inflammatory process with fibroblastic proliferation. Fibrosis resulted, but at a distance one saw epithelial cells, isolated or in small groups, exhibiting all stages of degeneration. Williamson, Brown and Butler[8] found that brain cells at a distance of 0.5 cm. from the radium capsule showed distinct and marked nuclear changes when the brain was removed three weeks following 200–900 mg. hrs. of surface application beneath the dura. Pendergrass *et al*[27] noted "distinct evidence of involvement of the various tissues of the brain, at least as far again as the areas of necrosis and hemorrhage seen grossly."

In sections of the pancreas removed seven and fourteen days after radiation, cells were observed well beyond the area of necrosis and hemorrhage, which showed degenerative changes of both nuclei and cytoplasm. In one case of metastatic carcinoma of the breast to the axillary lymph-glands, operated upon by one of us, section of the gland removed two weeks after 300 mg. hrs. of needle implantation showed dissolution of the chromatin of the nuclei almost 1 cm. from the site of insertion of the needle. Comparing our findings with those of others, one can not help but be impressed with the apparent resistance of the thyroid to radium rays. Whether this resistance is due to the colloid contained in the thyroid, to the adult fixed character of the cells composing it, or to a deficiency in autolytic ferments, we are not prepared to state; but comparison of results with those obtained in other organs and tissues rich in enzymes and autolytic ferments would point toward the latter as a possible explanation.

CONCLUSIONS

1. The primary changes induced by radium in the thyroid are hemorrhage and necrosis. Organization and healing are evident in the third week and complete about the twelfth.

2. The normal thyroid gland is distinctly resistant to the action of radium; it is not a good tissue for the study of the finer histologic changes produced by radium; the nuclear degenerative changes, characteristic of radiated malignant tissue, were never seen.

3. No toxic symptoms of any sort were observed.

4. No changes were demonstrable in the parathyroids.

5. The apparent resistance of the thyroid tissue to radiation would make it appear that implantation would be superior to surface applications, and that relatively large dosage must be employed to assure any extensive effect upon the gland.

We are greatly indebted to Dr. J. Edwin Sweet, in charge of the Department of Surgical Research, under whose direction this work was done.

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A RADIUM APPLICATOR FOR SMALL LESIONS

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ONE of the noticeable effects of the campaign of cancer education is the increasing number of patients who consult the dermatologist for small lesions about the face. It has been my experience that a majority of these lesions are less than one centimeter in diameter; and to treat them properly with radium one must either make use of a leaden window-screen or provide an applicator sufficiently small in size to cover but the lesion itself. Many of the lesions are very awkwardly situated about the eyes, ears, nose and lips, where the conformation of the parts makes their approach with anything but a very small applicator exceedingly difficult. To attempt their treatment with plaques of standard size necessitates the use of a window-screen to protect the surrounding healthy tissues, and very frequently, this cannot be placed in such position as to insure the proper approximation of the radium.

In a previous issue of this journal (January, 1922) Drs. Quick and Johnson of the Memorial Hospital, N. Y., described a method for the rapid destruction of small lesions by the use of a very small glass bulb containing 600 mc. of radium emanation. An exposure of two minutes was sufficient to clear up entirely a rodent ulcer 8 or 10 mm. in diameter; and, with a freshly prepared bulb, they were able to treat from 40 to 50 cases in an afternoon. Aside from the enormous saving in time, this method insures accurate application of the radium to any visible lesion.

The little applicator herein described was the result of an attempt to adapt their *multum in parvo* idea to plaque form, hoping thereby to gain the facility and accuracy of approximation which they have proven are possible of attainment with applicators of small dimension. Since there is an upper limit to the amount of radium which can be used per unit (12½ milligrams per square centimeter being the maximum which has been found practical), the saving of time with a plaque of the greatest possible concentration is hardly to be compared with that obtained with the emanation applicator described above. However, it is considerably greater than can be gotten with the ordinary standard plaque applied with a window-screen.

The applicator which I have been using with much satisfaction for the past year

or more is circular in form and approximately one centimeter in diameter. From its back projects a lug which is one-quarter of an inch in diameter and threaded to facilitate its attachment to almost any type of handle or supplementary retaining-applicator. The radium element is incorporated in a glaze which is fused in a shallow recess on the face of the plaque. Because of its small size and light weight, a thickness of double-faced adhesive-plaster is usually all that is required to retain it firmly in position (Fig. 1). Should screening be desirable, the filter can be mounted upon the face of the plaque between two discs of double-faced adhesive, or it may be placed within the shallow cap

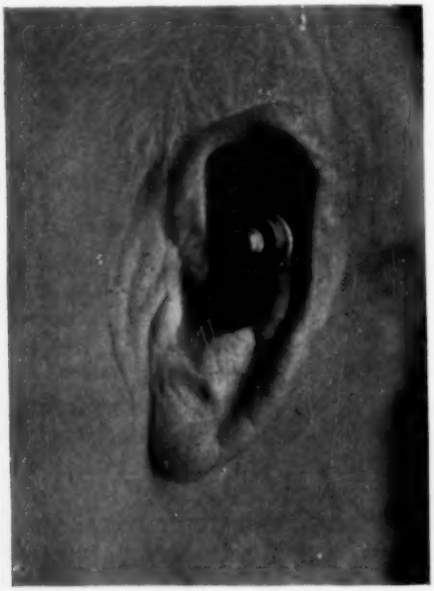
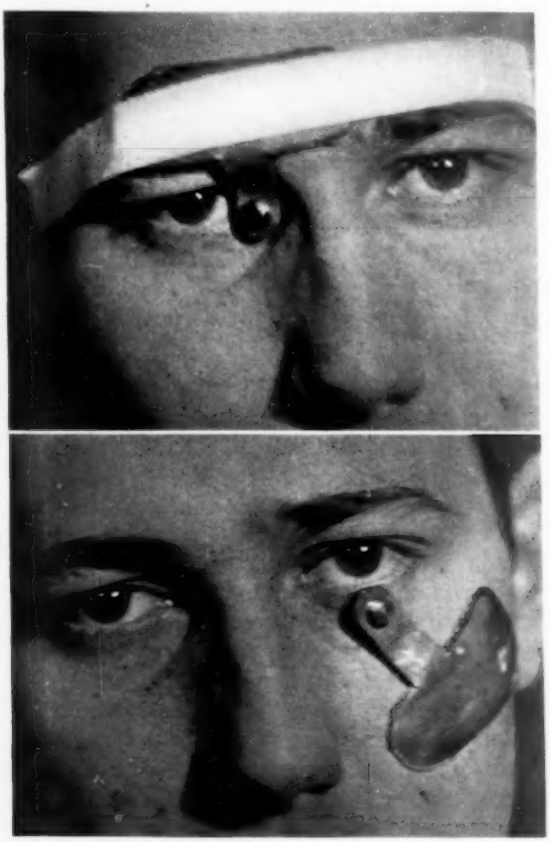


FIG. 1. Showing method of applying the small plaque by means of double-faced adhesive plaster. (In this case two thicknesses of the adhesive were used with 0.1 aluminum between them.)

of hard rubber made to fit snugly over the applicator. When round plaques are used I find it expeditious to cut the filters and adhesive plaster in disc form the exact size of the plaque with circular, open steel punches. Window-screens, when required, may be cut out in the same way. This insures greater accuracy in application.

When lesions about the eyelids are to be treated, some form of retaining device is often required. To those who are mechanically inclined, many such devices will suggest themselves. The T-shaped finger-plate shown in the accompanying illustrations (Figs. 2 and 3) is rather crude, but it has served me very satisfactorily for a year or more and has, I believe, some points of advantage over more complicated appliances. It may be cut very quickly from one millimeter sheet lead, to suit the case in hand. It is light in



FIGS. 2 and 3. Showing the use of the lead finger-plate to insure accuracy of approximation about the eye.

weight, it permits of easy moulding with the fingers to fit the parts and it will retain its position indefinitely when properly applied. After the plate has been cut and moulded to the parts, the corners and edges should be rounded off with a rasp and a hole punched in the end of the finger to receive the plaque. The hole should be punched a trifle smaller than $\frac{1}{4}$ in. in diameter and then threaded with a $\frac{1}{4} \times 40$ machine-tap. A few turns of the tap will yield a thread sufficient to hold the plaque snugly when screwed home. A thickness of

the double-faced plaster applied over the back of the plate is sufficient to retain it firmly in position, but added security may be gained by adding a strip of ordinary adhesive over the whole. A disc of the double-faced plaster the exact size of the plaque is then cut and placed over the face of the plaque, serving instead of the usual rubber screen and at the same time insuring an approximation of the radium which is both close and secure. The patient's hands are free, and he may lie down or move about as he pleases without fear of disturbing the applicator.

For the treatment of the small vascular angiomas of infancy and childhood, this little applicator is particularly serviceable. If the lesion is smaller than the plaque, a window-screen will be needed; but it will be so small in size and so light in weight that its proper placing and retention is a simple matter. It may be made up very neatly and quickly from one millimeter sheet-lead and a thickness of the double-faced plaster. The plaster is laid on the lead and a disc cut with the plaque-sized punch. Then with a smaller punch, the exact size of the lesion, the window is made. Our window-screen now resembles a corn-plaster with an adhesive base, and permits of great accuracy in application—an important factor in treating these conditions. When the window-screen has been satisfactorily and firmly placed, the plaque, covered with a disc of the double-faced plaster, is applied. With children it is best to add an extra strip of ordinary zinc oxide adhesive, punching a ¼ in. hole in its center through which the lug may protrude.

AUTOMATIC OPERATION OF THE POTTER GRID

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DR. POTTER'S moving grid, which suppresses much of the scattered radiation so objectionable in roentgenograms of thick parts, is now well known to roentgenologists everywhere. The present article describes a simple modification of one of the commercial types of his instrument, to facilitate its routine use in hospital practice.

The device, as supplied by the manufacturers, is a separate unit designed to be placed on top of the exposing table. The grid is cocked against spring pressure, and when released by the tripping of a trigger, moves through an arc between the object and the film at a speed which is controlled by regulating the valve of an oil drag. This valve is calibrated in terms of time for complete grid excursion, or in other words, in terms of grid speed.

If there are to be no grid shadows on the film, the grid must start to move before the beginning of the exposure and continue uniform motion until the exposure is completed. To accomplish this, the following procedure is necessary. One determines the time of exposure required (say three seconds), sets the oil drag valve at about four seconds, pulls the string to trip the grid trigger and then closes the *x*-ray time switch. Practically, it is difficult to obtain proper synchronism between grid and exposure; furthermore, the grid unit is heavy to lift on and off the table, and the patient is very uncomfortable unless supported by pillows or concave blocks. It was an obvious improvement to build the grid unit into a special table with concave top. Many such tables have already been described; but it seems equally obvious that the grid can be made to control the exposure automatically. This we have done; but as yet, no other such attempt has come to my attention.

Our table is a standard article of American manufacture with cast-iron base, wooden top and metal guide-ways at one side, along which moves the mast of the tube stand. This we remodelled as follows: the top of the table was removed, the base castings were cut off, and a substantial iron frame was added, to which the grid unit was securely bolted, so that its center was 44 in. from one end of the table

and 32 in. from the other end. A segment of wooden block, 31 in. long, as wide as

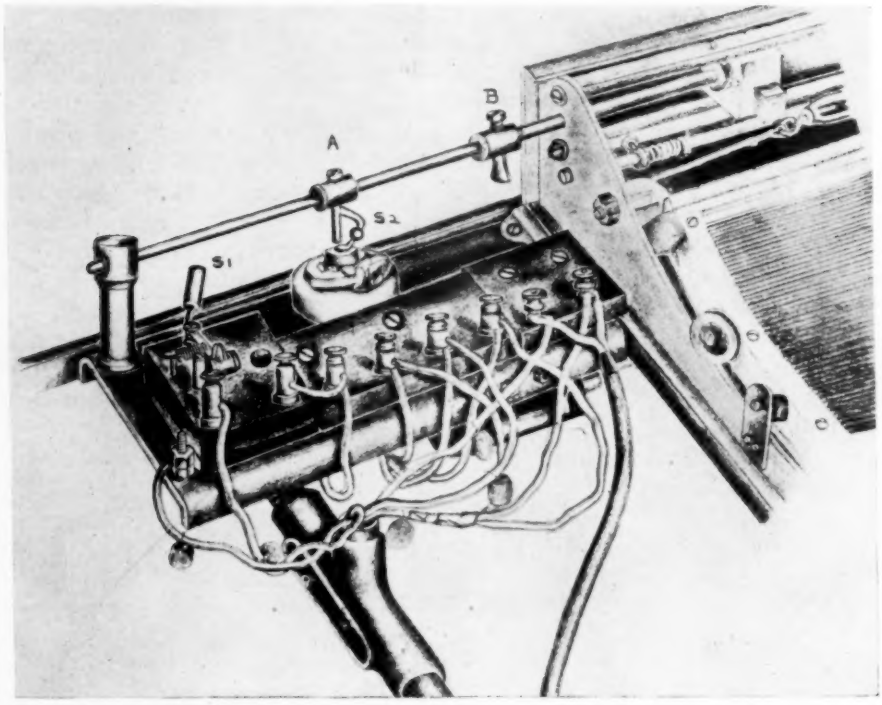

FIG. 1. Sketch showing grid at the end of its travel, just after lever A has opened switch No. 2. Note: In the cocked position, lever A holds switch No. 1 open; and lever B snaps switch No. 2 to the closed position.

the grid unit, and with the same surface concavity was bolted to the frame, filling

FIG. 2. Table with built-in grid. One wooden block (the smaller one) has been removed to show the switch mechanism.

the space between the grid and one end of the table. A similar segment, 19 in. long, was fitted to the other space on the frame, but was not bolted in place. The piston rod of the oil drag was lengthened 17½ in. and a hole drilled in the grid frame to allow this lengthened rod to project. This provided a member which moves out as the grid is cocked, and back into the frame with uniform speed proportional to the speed of the grid, when the grid is released.

A sheet metal shelf was riveted to the table frame beneath the extension of the piston rod. To this were fastened a support-bearing for the end of the rod and two switches: No. 1, designed to close automatically by spring pressure, No. 2, a common English snap switch, which stays either on or off. These switches were wired in series with each other and with the magnetic circuit of the remote control switch of the *x*-ray machine. Closing both switches closes the *x*-ray remote control switch and produces *x*-rays to the tube; while opening either stops the rays.

Two levers were attached to the piston rod, so arranged that, with the grid cocked,

switch No. 1 is open; No. 2, closed. The grid release trigger was provided with a solenoid release, instead of the string supplied by the manufacturer, and the button for this solenoid was placed on the *x*-ray control board. By pressing this button, the grid is released and starts to move. Simultaneously, the lengthened piston-rod moves; switch No. 1 is automatically closed by its spring; *x*-ray goes on; the grid nears the end of its travel; switch No. 2 is opened; *x*-ray goes off; the grid stops.

In cocking the grid, the lever A opens switch No. 1 just before lever B closes switch No. 2, so that the *x*-ray switch is not turned on in the process of cocking.

The oil drag was recalibrated in terms of *x*-ray exposures. Thus, the new procedure is reduced to: Determining the exposure; setting the oil drag valve; cocking the grid; and pressing the button of the magnetic grid release. The grid, by its motion, automatically puts the *x*-rays on and off.

A SIMPLIFIED ROENTGENOGRAPHIC TECHNIQUE BASED ON EXPERIMENTAL EVIDENCE*

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IT IS needless to mention the numerous techniques that have been developed by the pioneers in roentgenography. Everyone knows that there are as many different roentgenographic methods for a particular part as there are roentgenographers. In this paper I will not add to the number of techniques for particular parts, but will try to point out a method which is easily applicable to every part of the body, does not include any burdensome tables, is mastered after a very short period of its application and automatically decides the quality and intensity of radiation to be used for a particular part. This method also automatically decides when to use intensifying screens to get optimum contrast and still retain detail.

I. The greatest difficulty which a beginner in roentgenography encounters is the exposing in stout patients, especially, of those parts which cannot be brought close to the plate; for instance, hip-joints, kidneys, and laterals of the spine, especially those of the lumbar-sacral junction. The difficulty is primarily due to either or all of the following reasons:

1. Many roentgenographers use a fixed spark-gap: especially is that true with those that have non-rectifying machines; and they correct for the increase of thickness by increasing the milliampere seconds, but they do not consider the importance of voltage in obtaining proper negatives.

2. Others correct for the increase of thickness of the part to be taken by increasing the spark-gap (voltage); but the difficulty they encounter is the estimation of the necessary increase for a particular thickness.

3. Either method mentioned above rarely increases properly the intensity for the increased thickness of the part. They either leave target plate distance the same for all different thicknesses, or they increase the target plate distance in stout patients: a condition which leads to diminished intensity (fewer rays per square area), which, in turn, gives a diminished effect on the emulsion of the film or plate, and these effects are, of course, the reverse of what is desired.

With a view of eliminating the above-mentioned difficulties, and in order to show the practical rôle that variation of distance plays in exposure, the writer investigated the subject by making exposures under a variety of conditions, studying the effects on plate and on film with special reference to contrast and detail. The exposures thus made were of two main groups:

* Approved for publication by the Surgeon-General, U. S. P. H. S.

(*A*) *Blank Exposures* (exposures made with only air between the tube and plate or film).

(*B*) *Interposed Exposures* (substance of same density as body tissue; as paraffin or water placed between the tube and plate or film).

(*A*) In comparing the effects of the various *Blank Exposures* it was found that the effect on the plate or film is the same whether we use a 3 in. gap at 20 in. target plate distance or a 5 in. gap at 33 in. target plate distance, the milliampere seconds of exposure being equal. The effect is also the same when we use a 4 in. gap at 20 in. target plate distance as with a 5 in. gap at 25 in. target plate distance, the milliampere seconds of exposure being equal. Also, the effects on the plate or film are similar when using a 6 in. gap at 20 in. target plate distance as a 5 in. gap at slightly less than 17 in. target plate distance, the milliampere seconds of exposure again being equal.

Gap, in.	T. P. D., in.	= Gap, in.	T. P. D., in.
3	20	5	33
4	20	5	25
6	20	5	17 —

In other words, by using a constant 5 in. gap and varying the target plate distance we can get the same effects on the emulsion as when using a constant distance and varying the gap.

Figure 1 shows in the upper row a non-interposed exposure at standard distance with variation of the spark-gap, using 5 milliampere seconds for each exposure; while the lower row shows a constant 5 in. gap with variation of the distance; the milliampere seconds of exposure being 5 as above. From this figure it is quite evident that the effect on the plate or film in non-interposed (blank) exposures is *nearly* the same when using a constant gap and varying the target plate distance between 16 and 33 in. as by the use of a constant distance and varying the spark-gap between 6 in. and 3 in.

(*B*) In studying the effects of the interposed exposures we find similar results as when using "blank exposures," although the factors of scattering and secondary radiation are more pronounced on account of the interposed medium.

Figure 2 shows an interposed exposure in which tap water (almost the same density as living tissue) in columns 2, 4 and 6 in. respectively, was used as the interposing medium. A piece of the distal end of a tibia was placed in the fluid in order to compare the penetrability and intensity, and their combined effect on the emulsion. The odd rows beginning from above show the results of the variation of the gap at a 20 in. distance, while the even numbered rows beginning from above show the results of the variation of distance on a constant 5 in. gap, the milliampere seconds of exposure proportional to the thickness which will be described later. But the milliampere seconds of exposure are the same in row 1 as in 2, in 3 as in 4, in 5 as in 6. The results in detail and contrast are as good as by varying the gap; and with increase of the interposed thickness, we get greater detail by diminishing the distance than by increasing the gap; possibly on account of the greater scattered radiation produced by currents of high spark-gaps which blur the image.

II. From observations thus far presented, we calculated a formula which has served us admirably in finding the necessary target plate distance, in order to get the best penetration and intensity. Penetration and Intensity Formula:

$8G - 3M = D(A)$ for bone radiography.
$8G - 2M = D(A')$ for soft tissue radiography.

Expressed in words, it means that eight times the spark-gap minus three times the solid mass interposed (that includes bones, muscles, fat etc., but not air) equals the required target plate distance, T. P. D. or, in short, D. for bone radiography (A). And eight times the gap minus two times the thickness of mass to be radiographed equals target plate distance for soft tissue radiography (A'). It is always best to use the minimum voltage (spark-gap) that will be sufficient to give the desired penetration, rather than the maximum; as the former gives better contrast and good detail.

But how is one to know what gap to use in a given case? If a definite T. P. D. is desired, one can find it by reversing the formula (A) $\frac{D + 3M}{8} = G$

For example: The part to be radiographed is 4 in. thick, measuring it in the direction of the central ray, and the desired T. P. D. is 20 in. then gap = $\frac{20 \text{ in.} + 3 \times 4 \text{ in.}}{8} = G = 4$ in. = necessary gap for that thickness. But if, on the other hand, a 3 in. gap is desired, or no other is available, and we wish to radiograph a part of 4 in. in thickness, then we shall have to calculate for distance in order to get the proper radiation intensity. The distance as calculated by the formula for bone radiography will be:

$8G - 3 \times 4$ in. $= D = 8 \times 3 - 12 =$ 12 in. T. P. D.

Similarly, if we wish to find out whether a 2 in. gap is sufficient, apply formula as above, again calculating for distance, namely, $8G - 3M = D$. $8 \times 2 - 3 \times 4$ 4 in. T. P. D. or D. But the part alone takes up 4 in. If we could place the target immediately over the part to be radiographed, we would get the necessary intensity; but this is impossible, as the target is usually about 2 to 4 in. away from the wall of the tube, and, in addition, a cone or a lead diaphragm may be wanted between the tube and part. We therefore have to account for the distance between the target and the end of the cone, also for the thickness of the part which we want to radiograph. Assuming that there is 10 in. between the target and end of cone, the combined shortest target plate distance possible is 10 in. + 4 in. or 14 in. T. P. D. Now, if we want to find out the value of the necessary gap at that distance, we apply formula (A) reversed: $\frac{14 + 3 \times 4}{8} = G = 3\frac{1}{4}$ in. required spark-gap at 14 in. T. P. D. in order to radiograph a part, the thickness of which is 4 in. Thus, to estimate the necessary gap, we add the T. P. D. we intend to use to 3M and divide by 8. If we want t oradiograph a part 10 in. thick, we would have 10 in. from target to skin and 10 in. the part itself, and 3×10 according to formula (A)—altogether 50 in.; dividing

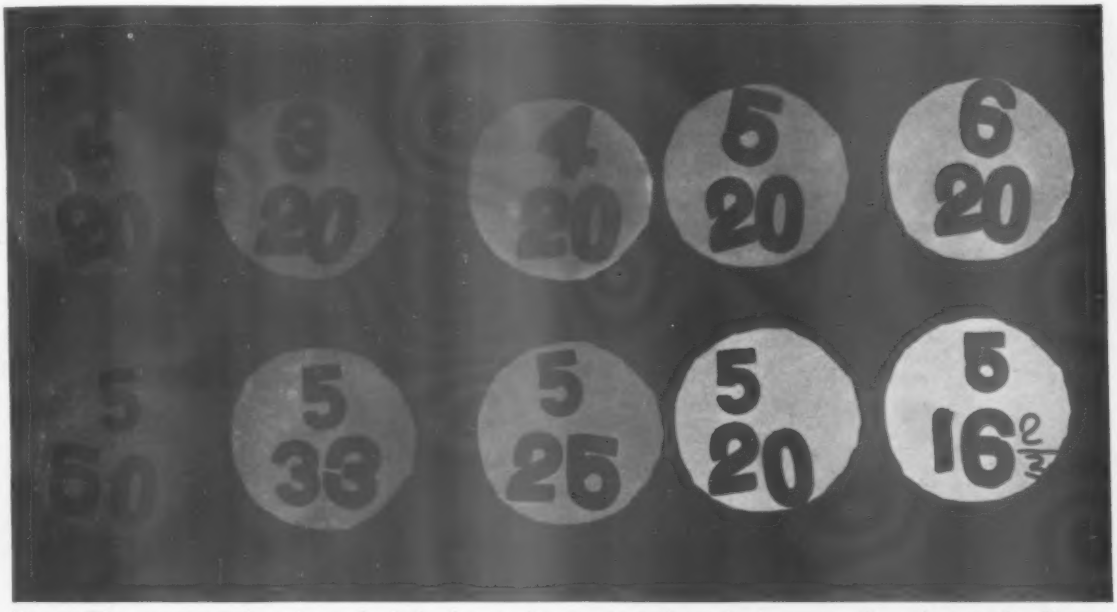

FIG. 1. The upper numbers in each circle denote the gap in inches; the lower numbers denote the distance between target and film in inches. Five-milliampere current was used for one second in every one of the ten exposures. The film was placed in a single thin paper envelope. Note the comparative density between each upper exposure and its corresponding lower-row exposure.

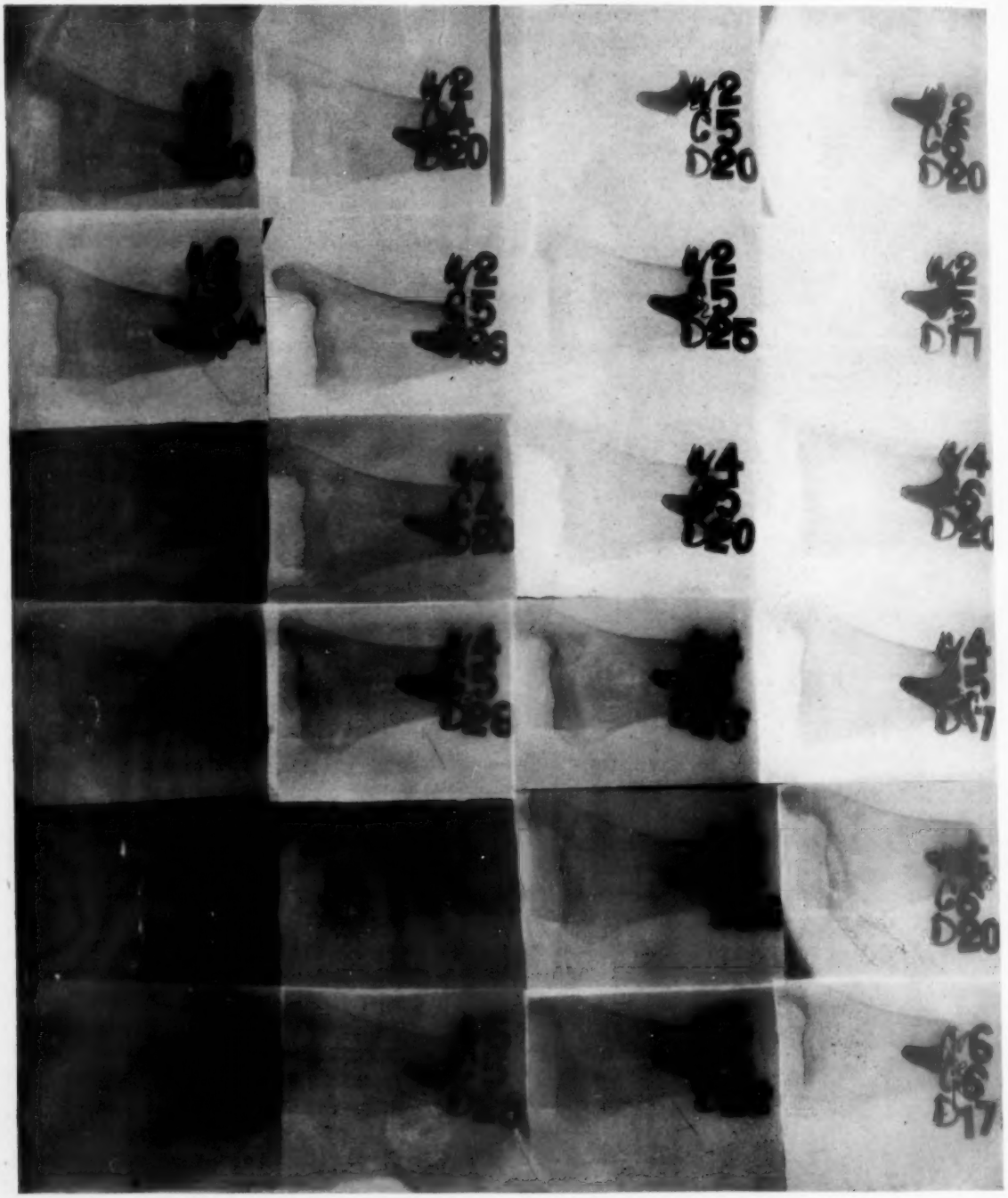

FIG. 2. The top number in every exposure represents the volume of the water phantom in inches. The second number represents the gap in inches and the third number represents the distance in inches. Note that in the odd rows there is a variation of the gap on a constant distance, while in the even numbered rows beginning from above, there is a variation of the distance on a constant gap.

50 in. by 8 = 6¼ in. = the necessary gap for that thickness at 20 in. T. P. D.

$$\frac{10 + 10 + 3 \times 10}{8} = G = 6\tfrac{1}{4} \text{ in.}$$

Manipulating the above formula, therefore, we find that varying either target plate distance or gap, similar satisfactory results are obtained, as far as contrast and detail are concerned. In the course of its practical application it was found that using a fixed gap, say 4 or 5 in. and varying the T. P. D. served our purpose well. Our formula for penetration and intensity for bone radiography was (*A*)

8G − 3M = T. P. D. or D. Using a 5 in. gap formula reads: 8 × 5 in. − 3M = T. P. D. or 40 − 3M = D.

Example in computing target plate distance on a constant 5 in. gap:

Knee-joint, anteroposterior, centered perpendicularly half an inch distad to inferior border of patella. If it is 4 in., the computed target plate distance will be: according to formula (*A*), i.e., 40 in. − 3 × 4 in. = 28 in. target plate distance, in which 40 = gap distance for 5 in. gap, 3 = factor used in bone radiography, 4 = thickness of the part.

Another example: A knee-joint is 6 in. thick, ½ in. below the patella in the direction of the normal ray. The computed target plate distance will be:

40 − 3 × 6 in. = 22 in. target plate distance

Another example: Hip taken for bone detail if it is 6, 7 or 8 in. our target plate distance will be:

40 − (3 × 6 in.) = 22 in. target plate distance

40 − (3 × 7 in.) = 19 in. target plate distance

40 − (3 × 8 in.) = 16 in. target plate distance

In the last case, it is evident that the computed 16 in. target plate distance cannot be applied, because the diameter of the hip takes up 8 in. of space and there is only 8 in. left between the body and the target. This distance is not sufficient for the average tube stand with cone. In such and similar cases, the difficulty may be overcome in one of the two ways:

1. By increasing the spark-gap to 6 in. and using 8 × 6 or 48 instead of 40 as gap distance factor and computing thus: 8 × 6 − 3 × 8 = T. P. D., i.e., 48 − 24 = 24 in. T. P. D.

2. Or in case no higher gap is available, use a double screen and change the gap distance factor to 8 × 8* or 64 instead of 40 and compute thus:

64 − 3 × 8 = 40 in. target plate distance with double screen.

III. We, among others, F. H. Kuegle,[1] I. S. Hirsch[2] and W. W. Mowry,[3] have found that the milliampere seconds of exposure are also proportional to the thickness of the mass, providing proper penetration is used. If we multiply the thickness of the mass by the emulsion factor† and divide the product by the milliamperes of the machine used, the quotient will equal the number of seconds of exposure necessary to give the optimum energy, thus:

Formula B $\frac{E \times M}{MA} = T$. Expressed in words it means that the emulsion factor† times the mass divided by the milliamperes of the machine equals the number of seconds = T.

Example for seconds of exposure we take from Figure 2. In the first two rows the thickness of the mass was 2 in., the emulsion factor for the films was 40, the milliamperes of the machine were 20 and the

* At this point it is important to review some of our findings in the experiments with intensifying screens. Using Edwards screens we noticed that there is an entirely different relation between the exposure factors (such as thickness of the part, spark-gap, target plate distance and milliampere seconds of exposure) and the unaided film on one hand; and between exposure factors and screened films on the other hand. For example, by using 1 in. gap at 40 in. target film distance with 2 mm. of aluminum as filter, there is no particular difference between the unaided and aided films. On a 2 in. gap the screened film shows only an intensity five times as much as the unaided film on a 2 in. gap. On a 3 in. gap the effect of the screened film is the same as the use of an unaided film with a 4 in. gap and five times as much exposure. With a 4 in. gap the intensity of the screen is the same as by using a 7 in. gap and five times as much exposure. This of course gives some idea of the dissociation of the relation between the factors of exposure on the one hand and the aided and unaided film on the other hand when non-interposed exposures are made. When a 5 in. gap is used with a double screen in interposed exposures, its effect on the film is the same as the use of an 8 in. gap with no screen. (Unpublished communication.)

† The emulsion factor is obtained by exposing on one plate or film a hip of 6 in. thickness and a toe of 1 in. thickness, and also some intermediate part of 3 in. in thickness. The target plate distance and time should be calculated according to method above mentioned, using 30 as a temporary emulsion factor. If the density of the hip and toe is the same, the emulsion factor for these films is 30. If the hip appears less dense, make similar exposures on another film or plate (whatever is used in the particular laboratory) increasing the number to 35, 40, 45, 50 or 55, etc., until the density between the hip-bones and those of the toe is uniform; and whatever number was used to give this uniform density is the emulsion factor.

number of seconds of exposure was:

$$\frac{2 \times 40}{20} = 4 \text{ seconds}$$

In the middle two rows the thickness was 4 in. on the same setting and the number of seconds of exposure was:

$$\frac{4 \times 40}{20} = 8 \text{ seconds}$$

In the lower two rows the thickness of the volume was 6 in. on the same setting and the number of seconds of exposure was:

$$\frac{6 \times 40}{20} = 12 \text{ seconds}$$

Now let us see how the formula is applicable for practical radiography.

Part	Position	Thickness, In.	Corrected Thickness, In.	T. P. D. Formula, In.	T. P. D., In.	Exposure Formula, In.	Seconds*
1. Finger	P. A.	½	½	$40 - (3 \times \frac{1}{2})$	$= 38\frac{1}{2}$	$\frac{40 \times \frac{1}{2}}{40}$	$= \frac{1}{2}$
2. Wrist	P. A.	$1\frac{3}{4}$	$1\frac{3}{4}$	$40 - (3 \times 1\frac{3}{4})$	$= 34\frac{3}{4}$	$\frac{40 \times 1\frac{3}{4}}{40}$	$= 1\frac{3}{4}$
3. Wrist	Lateral	$2\frac{3}{4}$	$2\frac{3}{4}$	$40 - (3 \times 2\frac{3}{4})$	$= 31\frac{3}{4}$	$\frac{40 \times 2\frac{3}{4}}{40}$	$= 2\frac{3}{4}$
4. Elbow	A. P.	$2\frac{3}{4}$	$2\frac{3}{4}$	$40 - (3 \times 2\frac{3}{4})$	$= 31\frac{3}{4}$	$\frac{40 \times 2\frac{3}{4}}{40}$	$= 2\frac{3}{4}$
5. Shoulder	A. P.	5	5	$40 - (3 \times 5)$	$= 25$	$\frac{40 \times 5}{40}$	$= 5$
6. Knee	A. P.	4	4	$40 - (3 \times 4)$	$= 28$	$\frac{40 \times 4}{40}$	$= 4$
7. Hip	A. P.	6	6	$40 - (3 \times 6)$	$= 22$	$\frac{40 \times 6}{40}$	$= 6$
8. Toe	P. A.	1	1	$40 - (3 \times 1)$	$= 37$	$\frac{40 \times 1}{40}$	$= 1$
9. Mastoid	Lateral	6	6	$40 - (3 \times 6)$	$= 22$	$\frac{40 \times 6}{40}$	$= 6$
10. Spine	Lumbar A. P.	6	6	$40 - (3 \times 6)$	$= 22$	$\frac{40 \times 6}{40}$	$= 6$
11. Spine	Cervical Lat.	4	4	$40 - (3 \times 4)$	$= 28$	$\frac{40 \times 4}{40}$	$= 4$
12. Spine	Mid-dorsal Lat.†	12	$\frac{12}{2} = 6$	$40 - (3 \times 6)$	$= 22$	$\frac{40 \times 6}{40}$	$= 6$
13. Chest for soft parts	P. A.	6	$\frac{6}{2} = 3$	$40 - (2 \times 3)$	$= 34$	$\frac{40 \times 3}{40}$	$= 3$
14. Abdomen for kidney	A. P.	6	6	$40 - (2 \times 6)$	$= 28$	$\frac{40 \times 6}{40}$	$= 6$

* The time of exposure would appear rather long. It is due to the use of old films which render the emulsion less sensitive.

† In the upper and mid-dorsal spine the lungs are on both sides of the bodies of the vertebrae, therefore we have to subtract from the lateral diameter of the chest the approximate thickness of the volume of air of the right as well as of the left lung approximately 6 in., or half the entire lateral diameter. In the lower dorsal laterally, the rays have to traverse solid organs: the liver, stomach and spleen; therefore no deduction should be made, and entire lateral diameter is to be considered excepting the gas bubble in the stomach, which is best eliminated by compression, displacing the bubble anteriorly to the bodies of the last dorsal vertebrae.

Figure 3 was made of a patient, height 5 ft. 7 in., weight 160 lbs. All the fourteen exposures were made on a single film and calculations made in the manner herein tabulated, using a 5 in. gap and 40 milliamperes on a D. C. machine. (For a. c. deduct ¼ of exposure time.)

From this figure it is quite evident that by using the above method we can not only get uniformity in the appearance of the radiograms, but we can also avoid the effects of poor judgment on the part of the one who develops the plates or films. Since all the fourteen exposures were taken on one film, the dark-room man could do very little to help or hinder any single exposure by under- or over-development. The developing is therefore done by time which is proportional to the intensity and temperature of the developer, and is entirely automatic.

SUMMARY

I. Variation of the milliampere seconds of exposure alone is not sufficient to give uniform roentgenograms, and the penetration has also to be varied.

FIG. 3. All the fourteen exposures in this figure were made on one film. Note that the density of the finger is nearly the same as the density of the hip, also A. P. and lateral of wrist are similar.

II. A tangible formula is offered for estimating the factors necessary for optimum results:

(*A*) The proper target plate distance *for bone detail* is obtained by multiplying the thickness of the part by 3 and the product subtracted from the gap by 8.

(*A'*) The proper target plate distance *for soft parts* is obtained by multiplying the thickness of the part by 2 and the product subtracted from the gap by 8.

(*B*) The milliampere seconds of exposure are obtained by multiplying the thickness of the part by the factor of the emulsion (for films from 30 to 40, plates 40, 50 or more); the product is then divided by the milliampere current of the machine, and the quotient is the number of seconds.

III. Finally, the diameter of the thickness of the mass of tissue to be radiographed offers an easy and fairly accurate index to the necessary gap, distance and time of exposure.

The aim of this paper would be fully realized if it should stimulate its readers to further investigation of this convenient and simple technique.

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RESULTS OF SKIN TESTS MADE TO DETERMINE AN OBJECTIVE DOSE FOR RADIUM RADIATIONS

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IN a previous publication certain generalizations were mentioned for the comparison of doses of radiation administered under different conditions. At that time it was considered inadvisable to discuss in detail the results of the biological tests made to compare radium radiation filtered through various thicknesses of brass and rubber.

We know that filtration is the factor which determines the quality of the radiation used. It is noteworthy that, unfortunately, there is little unanimity of practice regarding the choice of substances used as filters and their thickness. Workers who employ one type of filter find it difficult or impossible to compare therapeutic advances achieved elsewhere where a different filter has been used, because there is no means of translating the doses into common units.

It was with the idea of developing a method for interpreting different filtrations of radium rays by the same terms that this work was undertaken. Since no physical instrument has been devised for the purpose, we employed an empirical method, utilizing a biological indicator, namely the human skin, and as a standard dose, the radiation sufficient to cause a faint erythema.

It is well known that the degree of erythema produced on the skin of different patients by the same dose of radiation is not always the same. Therefore there must be a dose of radiation such as will produce no visible effect on the skin of the less radiosensitive patients, and a slight, but definite effect on the skin of the more radiosensitive patients. If we adopt this type of reaction as our standard of comparison, we can eliminate almost entirely the personal element on the part of the observer. In the experiments it was only necessary to determine whether an erythema did or did not appear following the application of a certain dose of radiation to the skin of many patients. If no erythema appeared on the skin of *all* patients treated, the dose was too low; if *every* patient showed an effect, the dose was too high. By repeated trials it is possible to determine the dose which produces an effect on 50 per cent of all patients, while the others show no apparent effect, the individuals being chosen at random. To be sure of such a dose, however, it is necessary to test a large number of patients in each

case for doses differing slightly from each other. Bearing in mind the practical applications of these experiments, it is evident that such extreme refinement is unnecessary. Accordingly it is sufficient to determine the dose which produces an erythema in the majority of patients, but still produces no visible effect on a certain percentage of the individuals treated. The latter point is very important, because it indicates that the dose is not too high, without relying on the intensity of redness observed.

It may be contended that one observer may see an erythema where another does not. In these experiments such errors are negligible, because, on account of the type of the applicator used, the small area affected by the radiation was completely surrounded by normal skin. Another precaution consisted in making the tests always on the same part of the body: the volar aspect of the forearm immediately below the antecubital fossa, on account of the different sensitivity exhibited by different skin areas of the same individual. Personal differences of the patients were taken account of by treating a large number of subjects of all ages and both sexes, who were suffering from a great variety of tumors in all stages. Normal persons were not available, ambulatory cases were unsatisfactory, and very weak patients were not likely to survive our period of observation. Therefore the finished records were obtained from those in a fair general state of health, and the doses arrived at may be considered as for the average cancer patient.

The erythema upon which the dosage is based appears usually within the fourth week after irradiation, but variations of one week earlier or later are not uncommon. In a considerable percentage of cases the erythema proceeds to the stage of bleb formation, and then subsides. This requires usually about a week. Then bronzing appears and may persist for an indefinite period. In some cases it has been noticed distinctly twenty-four months following these tests. Telangiectases have never been observed after our applications. The texture of the skin months afterward is normal, even when slight pigmentation persists. On account of the time required for the maximum effect to manifest itself, these experiments have extended over a period of nearly three years.

The experimental conditions for these tests were as follows: In a cork 4 cm. in diameter and 2 cm. high, a hole 2 cm. in diameter was bored. A thin silk ribbon was fastened across the top, and a slot was provided into which the brass filters were fitted. As secondary filters, discs of pure gum rubber were used, fitting into the hole of the applicator to make up the desired thickness. The source of radiation was, in every case, a tube of radium emanation 14 mm. in length and 0.5 mm. in external diameter, whose value in millicuries was known accurately. It was fastened to the silk ribbon with a little paraffin, so that it was always at a distance of 2 cm. from the skin of the patient. This distance was adopted in order to minimize errors due to possible variations in the distance of application. The applicator is shown in cross-section in Figure 1.

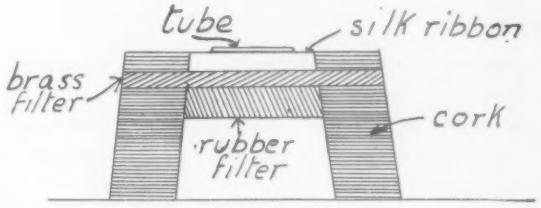

FIG. 1.

At the outset the dosage for each filtration which would produce the effect required, namely, the faint erythema, was not known and could not be predicted. Therefore the determinations were made entirely empirically. Whenever possible, clinical knowledge gained from radium treatment at the hospital was employed. For every filter, and the bare tubes, a rough estimate was made of a safe dose. This dose was administered to a number of patients, and depending upon the absence of any visible reaction or the quality of the skin effect which followed, alterations were made in the quantity of radiation applied.

The technique employed was as follows: a patient was chosen for the test; the emanation tubes were measured; the de-

sired filter was arranged for one tube and the other was left bare; the tubes were attached to their respective silk shelves with melted paraffin. Then the applicators were attached to the patient's forearm with adhesive plaster strips, using care not to lessen the skin distance by exerting too great pressure. As each applicator was attached to the forearm by one operator, another began timing with a stop watch.

The patients were occasioned no discomfort by these manoevers, and the subsequent examinations were usually made at the same time that a dressing was done.

Observations were begun at the end of twenty-four hours and after the first two days were continued at forty-eight-hour intervals until all akin reaction had ended.

On the basis of these tests the millicurie-hour doses corresponding to different filters, obtained in this manner, are shown in Table I.

TABLE I

Filter		Erythema Dose, Mc. Hours
Brass, Mm.	Rubber, Mm.	
0	0	7.5
0.16	1.2	30.0
0.32	1.2	100.0
0.50	1.2	250.0
0.75	2.4	425.0
1.0	2.4	630.0
2.0	2.4	800.0

It will be noticed that between the millicurie-hour dose for unfiltered radiation and that for radiation filtered through 2.0 mm., brass and 2.4 mm. rubber, there is a difference of more than a hundred fold. On this account it would have been very difficult to have kept the time of application approximately the same for all the tests made. Actually the applications with filtered radiation were considerably longer than with unfiltered rays, but, within the limits of time variation of these experiments, this had no detectable effect on the dose. Special tests were made before this conclusion was reached.

If we analyze the results of Table I, we find the millicurie-hour doses increase with the filter for two physical reasons: (1) The radiation reaching the skin through the filter is less in amount. (2) It is also more penetrating, and hence a smaller amount will be absorbed by the tissues. Since the biological effect is brought about by the radiation which is absorbed by the tissues, the millicurie-hour doses of Table I are related to the radiation which is effective in producing the observed changes. Furthermore, in the tests, all the physical conditions but one—the filtration—were kept the same, and therefore the millicurie-hour doses are inversely proportional to what we may call the "effective radiation" corresponding to the different filters.

The figures of Table I enable us to define the standard erythema dose objectively. It is that intensity of redness of the skin resulting from a radium application under the conditions described above, giving the dose which corresponds to the filtrations used. For instance, if a radium tube of 50 mc., whose total filtration is 2 mm. of brass, is available, it should be applied to the patient at a distance of 2 cm. (center of tube to skin surface) for sixteen hours to obtain the standard erythema. To make the conditions as nearly like those of the experiments as possible, the proper distance should be obtained by means of a cork support as already described, and the secondary filter should be 2.4 mm. of rubber. Tests should also be made on several patients, in order to get an idea of the average erythema obtained. If a thinner brass filter is available it should be used in preference to the thicker one, as the millicurie-hour dose will be smaller and the test will be more convenient. However, the unfiltered radiation from a radium tube does not quite correspond to that from an emanation tube, because the glass is thicker and the salt itself absorbs more of the radiation. The dose here given for unfiltered radiation, therefore, cannot be checked by those who do not use the emanation.

Each patient employed was tested with unfiltered as well as with the filtered radiation. The reason for this was that the erythema dose of the unfiltered radiation

had been worked out previously, and therefore the reaction obtained from this known erythema dose was used to check up our findings on the opposite forearm where the filtered rays were applied. In other words, this enabled us to tell whether or not the patient was especially radiosensitive, and the proper dose for filtered radiation could be arrived at more easily.

The "erythema dose" for the unfiltered rays was determined in the same empirical manner as mentioned above. It was found to be 450 millicurie minutes, or 7.5 millicurie hours for the 2 cm. skin distance.

We found that the unfiltered radiation caused the primary erythema to appear usually twelve to thirty-six hours after application, with twenty hours as the average, that it persisted for about three days and then disappeared, leaving no sign. Simultaneously with the advent of the secondary erythema resulting from the filtered radiation, there usually appeared a similar erythema on the forearm treated with the bare tube. This might or might not progress to bleb formation. It often was followed by bronzing of the skin.

Before comparing more closely the effects upon the skin of the filtered and unfiltered radiation, it might be pertinent to record our ideas concerning the tissue changes that are associated with the different radium reactions:

1. The primary reaction appears a few hours after treatment and is never stronger than an erythema. It seems to be a simple vaso-dilatation resulting from irritaton, and is not a specific result of radiation. If the dosage was light, this primary erythema disappears in two or three days leaving no sign, but if the irradiation was heavy, it will persist longer or may pass into

2. The secondary reaction. This varies largely with the quantity of radiation, and is but slightly altered by its quality. It may be of any degree, from the faintest erythema to the loss of considerable tissue. It follows the primary reaction at intervals, shorter with large doses, longer with smaller doses. This secondary reaction may be thought of as a local vaso-motor paralysis with dilatation of the blood-vessels, which in the more aggravated cases progresses to exudation of serum, hemorrhage, swelling of the endothelial cells with resulting occlusion of capillaries, the destruction of collogen fibers, and the endothelial and muscle cells of the vessels. Such changes appear as exfoliation of the dermis, and they progress to ulceration and necrosis.

3. Tertiary reactions now rarely occur. They have never been seen in these tests. During the earlier years of radium therapy they occurred with some frequency and followed the administration of a large dose of radiation. Occasionally they are reported in the literature as delayed radium burns. They appear about a year after irradiation and are manifest by ulceration at the site treated. The immediate cause is probably an obliterative endarteritis which cuts off nutrition to the part, necrosis following.

In contrasting the skin effects of the radiation produced in our tests by the bare and the screened radium emanation, we are really comparing the skin reactions of beta and gamma rays. Such a comparison might be of value in a study of the different reactions to the rays themselves, or might form the basis of a practical test, the use of which would assist in computing the dose of radium required to treat the individual patient.

In undertaking this experimental work it was recognized that there was a real need for the development of some preliminary test, the results of which would enable one to learn whether or not a person was especially radiosensitive, and in this way to assist in estimating the therapeutic dose to administer to this individual. Such a test, by demonstrating the general radium reactions of a patient, might be of value in prognosticating the effects of subsequent radium treatment.

We will consider the radiation transmitted by filters of zero and 0.16 mm. of brass to be principally beta radiation, and that filtered through 1.0 and 2.0 mm. of brass to be gamma radiation. For doses equivalent to each other as nearly as could be determined, no differences were noted in the reactions occurring within each group.

On the basis of our observations we have

noted that the beta rays cause (1) a promptly visible primary erythema, (2) a transitory primary erythema, lasting one or two days, followed by (3) a period of days or weeks during which time the skin appears normal, (4) a visible secondary erythema which appears at the same time as does the secondary erythema of the gamma radiation, but which is of slight intensity and of short duration, and leaves the skin of a normal texture and but moderately pigmented.

The gamma radiation results in (1) a primary erythema which appears usually on the second to fourth day after irradiation and persists for about a week, (2) a secondary erythema which usually appears during the fourth week and which may progress to bleb formation. This is followed by a bronzing, which when marked, persists for many months. Of course the reason for this seemingly more severe gamma secondary reaction is that a considerably greater depth of tissue is involved than is the case after exposure to the less penetrating beta rays.

The points of similarity therefore are (1) that the primary erythemata are alike qualitatively, and (2) that the secondary erythemata appear at the same time after treatment.

The points of difference are (1) that the beta primary reaction usually appears sooner after irradiation than does the gamma primary. (2) The beta primary disappears in a shorter time. (3) The beta secondary is not so severe a reaction, and is followed by less pigmentation. In addition, the gamma primary reaction appears less frequently than the beta primary, and this seems to have no fixed relation to the appearance of a subsequent secondary reaction or to its intensity.

Therefore, in our attempt to obtain data from which to formulate a test for simplifying and rendering more accurate the therapeutic administration of radiation, we have only a few possibilities as indicated in the foregoing summary. Such a test must be easy to perform. It should require so little time that the usual turnover of the hospital beds is not greatly retarded, and most important of all, it should be accurate enough to indicate within narrow limits the amount of radiation that the patient will tolerate. It should enable the intensity of the reaction to be predicted for both the patient's skin and the patient's tumor.

It is seen that the beta primary reaction has practically no differential value. Though it appears promptly, it does so with too great regularity, has almost the same intensity in all cases, and remains visible in all individuals for about the same period of time.

The beta secondary appears much later, and in addition possesses the same general faults as the beta primary, and is no better than the gamma secondary. The gamma primary, on the other hand, is too variable. Frequently it does not appear at all. It is often so faint as to be questionable, and this even when the dose is correct for the patient, as shown by the subsequent appearance of the secondary reaction. The gamma secondary possesses some very real value. It seems to be a better test of the patient's reaction. Furthermore, it records the reaction to the type of radiation of most frequent clinical usage. It may be accurate for all practical requirements, but it entails a period of observation of approximately a month. This is a real disadvantage. Other draw-backs to the routine use of this test are (1) the labor and time consumed, and (2) the use of radium for a purpose other than that of actual therapy.

It probably will be granted that these obstacles would be ignored provided the tests proved of sufficient value. For this reason it may be of interest to record the comprison between the results of our skin tests and those obtained by the therapeutic applications to the same patients.

The skin tests on these cases were made with the erythema doses as in Table I. The radium therapy was applied in accordance with the best usage by clinicians of different divisions of the hospital staff, and the patients represented many types of tumor growth. We may surmise *a priori* that those patients who showed visible skin reaction to the erythema dose might also respond favorably to therapeutic radiation, and those patients who gave negative skin tests might likewise fail to improve clinically after radiation treatment. In any case, if we found a definite

relationship between the observed effects of the skin tests and the therapeutic results of radiation, we could conclude that a suitable skin test would have a prognostic value.

Many possible factors of error are evident in attempting such a comparison, but with the patients chosen at random, and many types of tumors represented in all stages of development, and with more than 200 cases compared, a deduction may fairly be drawn, especially if the evidence is predominately in one direction. Clinical improvement was based upon the condition of the patient at least six months after treatment.

To simplify these analyses, two main divisions were made, namely (1) those which showed the secondary erythema, and (2) those which failed to respond to the skin tests with this reaction. Then the patients of each of these divisions were further classified according to whether (*a*) they responded favorably to the radium or *x*-ray applied therapeutically, or (*b*) they were not benefited by the treatment. In Division 1 it was found that of the patients who responded to the skin tests by developing visible secondary erythema, the ratio of benefited cases to those not helped was as 6:1.

In Division 2, consisting of those patients who failed to respond to the skin test by a secondary erythema, the ratio of the benefited cases to those not helped was as 1:11. These figures would seem to indicate that there is a relationship between the response of the skin to radiation and the effect of radiation upon a tumor in the same person.

The cause of this relationship may be some constitutional factor; and during the progress of the experiments notes were made concerning variability in reaction to radiation because of age, sex, complexion, personal idiosyncrasy, etc.

It was clearly shown that the young react to smaller doses than do adults and that the same doses cause a greater reaction in youth than in later years. Our records show that after sixteen years of age adult doses may be given. In senility the percentage of secondary reactions to the skin test was very low, and few of these senile individuals were benefited by radium therapy.

Sex variation seemed a negligible factor in our tests.

We obtained little if any quantitative difference in the skin tests because of complexion. The brunettes, however, reacted with a bronzing of the skin, especially after the secondary erythema, which was largely lacking in the blonds. In some white-haired individuals it was learned from the skin pigmentation whether they had previously been light or dark.

Regarding personal idiosyncrasy, it may be said that nothing has been noted that might not otherwise be explained. The writer gravely doubts its existence. However, one factor appears as most important in explaining cases of suspected idiosyncrasy, and this is the quality of the blood.

While it was impossible in this work to get perfectly normal individuals it was noticed that invariably weak reactions to radiation occurred in the anemic persons, and correspondingly strong reactions were associated with high hemoglobin and red blood-cell count. One case may be mentioned as illustrative of this relationship:

A well-nourished patient of normal body weight had had recent severe hemorrhage until his hemoglobin was 40 per cent and his red blood-cell count was 2,000,000 per cu. mm. He received the usual erythema dose of both bare and filtered radiation to the forearms. No visible reaction of any kind followed. Six weeks later some improvement in the general condition had occurred, and the same skin dosage was reapplied to other skin areas of the forearms. This test proceeded through all the stages of visible reactions at the usual time intervals. In addition, the areas first treated began to show very faint erythemata followed by faint tanning, which developed into a distinct bronzing during the course of about three weeks. On the day that the erythema appeared as the result of the first skin application, the hemoglobin had risen to 60 per cent, and the red blood-cell count to 3,200,000.

The somewhat fewer cases of emaciation with normal blood pictures reacted normally and readily to our skin tests.

Therefore in the search for a radiation test which might be performed easily, and would give an indication in a short space of time, we have failed, because while the secondary erythema from gamma radiation furnished such an indication, and in these tests was closely related to the therapeutic results, the period of observation is too long for its adoption as a routine procedure. Where the delay of a month is of little moment, it may well be employed.

On the other hand, the relationship between our skin tests, the therapeutic results, and the patient's blood quality has been so close as to warrant prediction of the effects of therapy within certain limits on the basis of this latter factor alone. This does not imply, by any means, that all patients with blood of good quality will be cured of their tumors, but it is valuable enough to prompt us to withhold treatment in certain cases and consider the patients as unsuitable for radium therapy until this factor either improves or has definitely failed to improve under a suitable regime, which might include blood transfusion. These statements should not be interpreted as in any way discouraging the use of radium to check hemorrhage, or simply as a palliation. Nevertheless it is believed that the results attending its use even for these purposes will be most discouraging when the blood quality is found to be poor.

Of course the blood count and hemoglobin estimation are at present a part of the routine examination in most hospitals, and the application of this test to the problem of the radiation treatment of any given individual causes no delay in his treatment, nor does it interfere with the activity of the hospital.

CONCLUSIONS

1. A method is described whereby skin erythema produced by radiation can be used as a standard of comparison, free from the usual subjective errors.

2. Using this as an objective biological indicator, the effect of filtration on radium radiation was determined.

3. The results (Table I) show in what proportion the millicurie-hour doses must be varied to produce the standard erythema with brass filters varying from zero to two millimeters. The millicurie-hour doses of Table I are for a distance of two centimeters. For any other distance they will be different but they will maintain the same relative values.

4. Having used skin erythema as a biological indicator, the results are directly applicable to skin dosage in radium therapy.

5. The determinations were made empirically, since no other method is available at the present time. The results, therefore, are not dependent upon any assumed correspondence between physical measurements and biological effects.

6. In attempting to formulate a skin test the result of which would enable us to treat the patients more accurately, we found that the secondary reaction to gamma radiation, when the erythema dose was applied, was closely associated with the subsequent therapeutic result. This finding was borne out in over 200 cases and for many varieties of tumor.

7. Among those patients who reacted with a skin erythema to the test application of radium, and received radium therapy, examination of the records at least six months afterward showed 6 benefited to 1 unimproved. Likewise, considering the class of negative skin tests, or those patients who failed to respond to the test application by the formation of a visible gamma secondary reaction, the number of those not benefited by radium therapy was greater than those who were improved in the proportion of 11:1.

8. It was found that the reactions to the radium skin tests were intimately associated with the quality of the blood of the patients tested. Those with normal or nearly normal blood reacted readily to the skin erythema dosage, while anemic individuals either failed to respond entirely, or reacted faintly and atypically.

9. The association between the positive skin test and favorable blood findings has been so close throughout these experiments that we believe the latter factor to be of the greatest prognostic value. On the basis of our results the patients with a normal or nearly normal blood picture, other factors

being equal, will be benefited or cured by radium therapy, while the anemic individuals will fail to show such a favorable response to the same treatment. We therefore recommend the routine blood examination of each cancer patient, both before radium treatment and during the course of observation, with the idea of maintaining a high hemoglobin content and red blood-cell count, so that the most favorable reactions possible may result from our radiation therapy.

In conclusion the author wishes to thank Mr. G. Failla for having suggested the problem and Mrs. Edith Quimby for her cooperation in making the tests.

WILHELM CONRAD ROENTGEN: IN MEMORIAM*

BY F. HAENISCH, M.D.

HAMBURG, GERMANY

THE German Roentgen Ray Society convenes, at its fourteenth meeting, for the first time outside of Berlin. The choice fell upon Munich. Our hope that this meeting would be distinguished by the presence of our most illustrious honorary member has been set at naught by the sad coincidence that the city where we now meet is the place of the death of the man to whom we all owe our gratitude. So it is a necessary and sacred duty to precede the business of the day by a brief memorial for our distinguished dead.

Wilhelm Conrad Roentgen is no longer among the living. On the 10th of February of this year passed one of the greatest discoverers and men of learning of all time. On the 13th of February a small select group paid him the last honors.

Roentgen was born March 27, 1845, in the little town of Lennepp in the mountainous region of the lower Rhine. His youth was spent in Holland. At the end of his studies in Zurich, in 1869, he was graduated from the technical college. As assistant of the physicist Kundt he came, in 1870, to Würzburg and in 1872 went with his professor to Strassburg, where, in 1874, he became a lecturer in the University. In 1875 he was called to a professorship in the agricultural college in Hohenheim and in 1876 returned to Strassburg as extraordinary professor. In 1880 he was called to Giessen as professor; in 1888, to Würzburg; since 1900 he had worked here in Munich, where in 1919 he retired from teaching.

In December, 1895, in the Physical-Medical Society of Würzburg, Roentgen presented his first epoch-making communication, "On a new kind of ray," which was followed on January 23, 1896, by the demonstration of further practical applications; this meeting closed with the making of the now famous plate of the hand of Geheimrat von Kölliker. On March 9, 1896, and May 13, 1897, two further communications appeared, to develop the epochal contents of which remained for the circle of roentgenologists. The astonishing fact is appreciated everywhere that Roentgen, in these three fundamental works, recognized almost completely the physical properties of the roentgen rays and in concise, accurate and exhaustive fashion described them; so that with all due respect to the value of the great number of physical works of many investigators, the great discovery by Laue of the wave nature of the roentgen rays has been the only important addition in a decade and a half.

The effect of these three communications on the whole civilized world was overwhelming. The surpassing greatness of his scientific deed lies in that Roentgen was the only one of the many experimenters who not only saw, but comprehended correctly, the empirical discovery, pursued it further and added to it; that he recognized that the observed manifestations were due, not to the cathode rays, but to a new and unknown kind of rays. That accident came to his aid, in no manner diminishes the greatness of his immortal work; only ill-natured envy could make such a criticism. On the contrary, in the ability to interpret correctly the accidents

*Presidential Address Delivered before THE GERMAN ROENTGEN RAY SOCIETY, April 16, 1923, Translated from the German manuscript.

which are never lacking when there are great discoveries, lies the greatness of the surpassing investigator.

But Roentgen not only exhaustively set forth, in his first works, the physical properties of these rays: and even predicted their relation to light rays, he had the vision of the epochal development which his discovery would bring about in medical science.

The further development of medical roentgenology, for which he had furnished the firm foundation, he left, with his modest reserve, to the medical men, who in turn because of the rapid extension and the lively progress of the method very soon called in the help of physicists and technical men, men of science and of the industries.

His great reserve and his antipathy toward acclaim repeatedly kept him from accepting invitations to honor our annual congresses, which early became the center of roentgenologic science and technique.

To speak in this forum of the comprehensive scope and the practical significance of roentgenology on its present plane seems to be superfluous. You all, ladies and gentlemen, are practical working witnesses that there is no branch of medicine or surgery that has not recognized the aid of the rays and made them serve its needs, in either diagnostic or therapeutic application.

Not only practical medicine, dentistry and veterinary medicine have made unforeseen progress through the extension of the discovery, but also the theoretical branches, anatomy, pathologic anatomy, embryology, physiology, biology, etc., have adopted roentgen rays with constantly increasing interest and profit.

In our enthusiasm, however, we medical men must guard as rigorously against a false, one-sided overestimate of the value of our diagnostic adjunct as against a summary subordination of it by a preconceived clinical opinion. An uncritical estimate of the roentgen findings, divorced from the results of the clinical examination, or a reading into it of things which the roentgenogram cannot show, involve a greater risk and more severe consequences than the entire omission of the roentgen examination. The roentgenogram is always correct, but it is not always interpreted correctly; more is demanded of it than should be. The roentgenologic demonstration of a pathologic process may fail, but to exclude such a process on this ground would be, in many cases, an error. In the ability to recognize its possibilities, still often narrowly limited, lies the art of the roentgenologist. A pathologic change may be shown in a roentgenogram, yet herein alone lies no proof that it is identical with the anatomical basis for the patient's complaint.

We can thank the great benefactor of suffering humanity no better than to strive to employ rightly the instrument he has given us, and that is not always easy. Roentgenoscopy and roentgenography compose no *pons asinorum* of medical diagnosis. Medical art and diagnostic development are not decreased by it, but on the contrary, enriched. Also, "nil nocere" must remain in the development of every technique the supreme medical watchword.

Notwithstanding the diligent work of unnumbered practitioners, investigators and scholars, the world awaits still further application and clarification in almost every province of medicine, physics, and technical use, and further progress in scientific and practical application. Despite the restraint which the world war and the revolution with its catastrophic consequences have placed upon the development of every kind of culture, we see in our province a fresh scientific effort and energy to which this present Congress may bear witness.

Medicine is not the only debtor to Roentgen's discovery for mighty strides. Innumerable other branches of natural science have taken the roentgen rays into their service: zoology and botany, paleontology and anthropology, even the graphic arts; but above all, chemistry, mineralogy and crystallography. Many problems of crystal-structure and molecular investigation must be studied completely anew with the aid of the roentgen rays; and the systematic investigation of the elements has acquired, through roentgenologic spectroscopy, an entirely new foundation.

Discoveries of such overwhelming importance have been rare in the history of science. Roentgen's deed and name will forever remain with those at the pinnacle of the greatest of all time.

We medical men know our Roentgen and estimate him and his greatness from *our* viewpoint and on account of the great discovery by which he has benefited *us*, while many of us are unaware of his tremendous importance in the realm of physics, aside from the discovery which almost overshadowed his other achievements. Many of us learned first from the memorial address of his successor to the Munich chair, Geheimrat Wien, that his other physical works alone would entitle him to a place among the greatest physicists of all time: works and discoveries which were of fundamental bearing upon the theory of electro-magnetics, and even upon the theory of relativity. Geheimrat Wien emphasized the absolute reliability, the rigor of proof, and the exactness of expression which distinguished Roentgen's productions from all others, and designated him as the best classicist in the exact sciences.

Other honors, well-deserved, were not withheld from Roentgen. In 1896 he was made an honor citizen of his native town. In the same year he received the Rumford medal of the Royal Society of London, and in 1900 the Barnard medal of Columbia University and the Nobel Prize for physics. He was an honorary member of our society, and of innumerable medical societies which bore his name. He was a member of the Prussian and Bavarian Academies of Science, a knight of high orders, and was elevated to the nobility and given the title of Excellency.

We hear of Roentgen's remarkable personal characteristics which have been but little known, of the high lights of his character, chief among which were uprightness, love of truth, self-criticism and modesty. He kept at his research with a pure idealism and never accepted material gain from the fruits of his labors.[1] The greater the fame he attained, the more retiring he became. His greatest satisfaction was the assurance that he had conferred upon humanity an imperishable blessing.

We physicians and natural scientists, and with us the whole of humanity, are eternally indebted to this greatest of the great. To our gratitude attaches still one thing without which it would be incomplete. In the memorable meeting of January 23, 1896, the venerable anatomist, von Kölliker, proposed to name the so-called *x*-rays after their discoverer. The proposal found unanimous approval. It should be to us a sacred duty to preserve the name of the immortal discoverer for all time, and to protect this nomenclature from indifference, and above all, from the ill-will of hostile foreign countries, in which attempts have been made to discontinue the name of the German discoverer.

While the designation "radiology" may be correct for the terminology of the science of rays, it should be impossible to speak of anything in relation to roentgen rays except in words carrying Roentgen's name; and terms such as "radiography" or "*x*-rays" should be proscribed.

I beg of you in token of your lasting gratitude and your respect, to rise. Let us in this hour of commemoration take the solemn vow that we shall strive to administer and protect Roentgen's legacy as he would have it.

[1] In a personal communication, Dr. Haenisch corrects the statement in the April number of the JOURNAL, that Roentgen died in poverty in the house of a friend: "Roentgen was not rich, for he absolutely refused to accept any financial or material advantages through his invention, but he lived in normal circumstances, after retiring from his professorship in 1919, in a village suburb of Munich."

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-FOURTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

CHICAGO, ILL., SEPTEMBER 18, 19, 20, 21, 1923

Headquarters, Meetings and Exhibits: Congress Hotel, Chicago, Ill.

AMERICAN ROENTGEN RAY SOCIETY

TWENTY-FOURTH ANNUAL MEETING PRELIMINARY PROGRAM

The preliminary program which is published herewith indicates that the forthcoming meeting in Chicago will be of such a character as to make it a memorable one, and it is hoped that not only members but all others who are interested in roentgenology will make an effort to be in attendance.

CALDWELL LECTURE

BROWN, DR. PERCY. (On the question of medical education and its relation to roentgenology.) Title to be announced.

FOREIGN CONTRIBUTORS TO BE PRESENT

COSTA, PROF. CALATAYUD, Madrid.
KNOX, DR. ROBERT, England.
FRIEDRICH, PROF. WALTER, Germany.
BUCKY, DR. GUSTAV, Germany.
HODGES, DR. PAUL C., China.

PAPERS ON THERAPY AND THERAPEUTIC RESEARCH

KNOX, DR. ROBERT, England. "Some Aspects of the Cancer Problem."

FRIEDRICH, PROF. WALTER, Freiburg, Germany. Title to be announced.

BACHEM, DR. ALBERT, Chicago, Ill. "Radium and Roentgen Rays as Different Agents in Superficial and Deep Therapy."

EVANS, DR. WM. A., and LEUCUTIA, T., Detroit, Mich. "Deep Roentgen Therapy of Neoplastic Pulmonary Metastases."

ULLMAN, DR. HENRY, Santa Barbara, Calif. Title to be announced.

GERBER, DR. I., Providence, R. I. "A Review of Therapy as Seen on the Continent."

DRS. FALCONER, ERNEST, MORRIS, LAIRD H., and RUGGLES, HOWARD E., San Francisco, Calif. "The Effect of Roentgen Rays on Bone Marrow."

GOOSMANN, DR. CHARLES, Cincinnati, Ohio. "Technique of High Voltage *X*-Ray (Combined with Radium)."

STEELE, DR. GEO. H., Oshkosh, Wis. Therapy of tuberculosis.

BECK, DR. EMIL, Chicago, Ill. "Cancer Therapy from the Surgeon's Standpoint."

PFAHLER, DR. G. E., Philadelphia, Pa. "Measurements of Four Different Types of High Voltgge *X*-Ray Machines by the Duane Method and the Friedrich Iontoquantimeter."

MARTIN, DR. CHAS. L., Dallas, Texas. "Roentgen Cachexia."

WILLIAMS, DR. JOHN G., Brooklyn, N. Y. "The *X*-Ray Treatment of Fibroids of the Uterus and Uterine Bleeding not due to Malignancy."

PORTIS, DR. SYDNEY, Chicago, Ill., and ARENS, DR. ROBERT, Chicago. "The Effects of the Shorter Wave-Length Therapy on Gastric Secretion of Dogs."

PIRIE, DR. A. H., Montreal, Can. "The Platinocyanide Pastille in Deep *X*-Ray Therapy."

LAWRENCE, DR. W. S., Memphis, Tenn. "High Voltage Treatment in a Series of Sarcoma Cases."

DUNHAM, DR. KENNON, Cincinnati, Ohio. "The Control of Hyperthyroidism."

SOILAND, DR. ALBERT, Los Angeles, Calif. "Evolution of *X*-Ray Therapy."

CASE, DR. JAMES T., Battle Creek, Mich. Title to be announced.

STEVENS, DR. J. THOMPSON, Montclair, N. J. "Technique and Statistics in the Treatment of Superficial and Accessible Malignancy with Radium, Roentgen Rays, and Electrothermic Coagulation."

PAPERS ON DIAGNOSIS

SPANGLER, DR. DAVIS, Dallas, Texas. "The Value of *X*-Rays in the Diagnosis of Atypical Pregnancies, with Report of Two Cases of Anencephaly Diagnosed Before Birth."

DOUB, DR. HOWARD P., Detroit, Mich. "Organic Hour-Glass Contracture of the Stomach with Some Reference to the Surgical Treatment."

HICKEY, DR. P. M., Ann Arbor, Mich. "Multiple Osteomyelitis."

CATHCART, DR. J. W., El Paso, Texas. "Bone Dystrophies of Smallpox."

NICHOLS, DR. BERNARD M., Cleveland, Ohio. "Hydronephrosis."

MOORE, DR. A. B., Rochester, Minn. Title to be announced.

MOORE, DR. C. N., Schenectady, N. Y. (General Elec. Co.). "Data on New Water-Cooled Tube."

MILLS, DR. R. WALTER, St. Louis, Mo. "*X*-Ray Evidence of Colonic Secondary Reactions."

GEORGE, DR. ARIAL W., Boston, Mass. Title to be announced.

GREEN, DR. J. H., Rochester, N. Y. "An *X*-Ray Study of 1500 Children Before and After Tonsillectomy Under Ether."

BOWMAN, DR. WM. B., Los Angeles, Calif. "Back Injuries."

KOENIG, DR. E. C., Buffalo, N. Y. "The Upper Left Quadrant."

GRIER, DR. G. W., Pittsburgh, Pa. "*X*-Ray Study of the Thymus Gland."

LEWALD, DR. L. T., New York, N. Y. "Lateral Roentgenography in Pulmonary Abscess."

JENKINSON, DR. E. L., Chicago, Ill. "Carcinoma of Gastrointestinal Tract Accompanied by Bone Metastases."

PHEMISTER, DR. P. B., Chicago, Ill. "Differences in Destruction of Cartilage in Tuberculous and Pyogenic Arthritis."

SANTE, DR. L. R., St. Louis, Mo. "Tuberculous Lobar Pneumonia."

SKINNER, DR. E. H., Kansas City, Mo. "Observations upon Opaque Residues in the Colon: Report of one case Harboring one Opaque Meal in the Colon for Five Weeks."

TYLER, DR. A. F., Omaha, Neb. "Dental Pathology as Revealed by the *X*-Ray Examination and Underlying Principle of Treatment."

STEWART, DR. W. H., New York, N. Y. "Some of the Pitfalls in the Roentgenographic Diagnosis of Colonic Lesions with Suggestions as to the Proper Method of Overcoming Same."

BLAINE, DR. E. S., Chicago, Ill. "Healed Miliary Tuberculosis of Lungs."

BASSLER, DR. ANTHONY, New York, N. Y. "Is Haudeck's Niche as Diagnostic of Ulcer as Believed?"

OFFICERS OF NEW ENGLAND SOCIETY

At its last meeting, the New England Roentgen Ray Society elected for its officers for the coming year the following: President, Dr. P. F. Butler, Boston, Mass. Vice-President, Dr. W. A. LaField, Bridgeport, Conn. Secretary & Treasurer, Dr. A. S. MacMillan, Boston, Mass. Member of Executive Committee, Dr. Geo. W. Holmes, Boston, Mass.

COMING MEETING OF THE ITALIAN SOCIETY FOR MEDICAL RADIOLOGY

The fifth congress of the Italian Society for Medical Radiology will take place at Palermo, October 18th to 21st inclusive. The program is announced as follows:

1. Address of welcome by the president of the society, Professor Gioacchino Scaduto.
2. Professor Rossi (Parma): Roentgen therapy of diseases of the skin.
3. Professor Gortan (Trieste): Pneumoradiography.
4. Professor Boidi Trotti (Torino): Radiographic diagnosis of the urinary system.
5. Scientific communications.

The secretary of the society is Dr. Salvatore Sgroi, to whom communications should be addressed at Via Alloro, 58—Palermo.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY *visiting New York City, are invited to make the office of* THE JOURNAL (*69 East 59th Street, New York*) *their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

TRANSLATIONS & ABSTRACTS

Abstract of Proceedings of the Fourteenth Session of the German Roentgen Ray Society, Munich, April 15–18, 1923.[1]

The meeting of the German Roentgen Ray Society occurred this year for the first time outside of Berlin and was coincident with the Congress of Internists in Vienna. Prominent in the work of the committees meeting on April 15th was the discussion of roentgen-ray injuries and protection against them. A manual of directions for their avoidance is to be issued, which will contain the statement of minimum demands for legal purposes. The executive committee decided to endeavor to obtain a ruling through a communication to the authorities, classing roentgen therapy with potent drugs (poisons) and preventing its unrestricted use; and further, to make it necessary for a license to be obtained to conduct a Roentgen institute.

In the great auditorium of the University Frauenklinik, the scientific convention opened on April 16 with a memorial address by the president, Professor Dr. Haenisch of Hamburg, in honor of the discoverer who died in February.

After greeting the guests, Haenisch opened the Congress (which was composed of 956 members) and the associated industrial exposition.

The first day was devoted to diagnosis, and was opened by a paper by Jehn of Munich, in collaboration with Sauerbruch, on the roentgenologic diagnosis of surgical disease of the lungs. The essayist submitted that two measures had made possible the development of surgery of the thorax: the pressure chamber which enables the thorax to be opened without immediate danger to life, and the exact roentgenologic diagnosis, which is so important for surgical procedure. In disease of the chest wall the roentgenologic examination often reveals otherwise unrecognizable involvement of the thoracic contents. The closed pneumothorax in all its forms and spontaneous pneumothorax are thoroughly investigated. The sharp relief of the lungs allows also the fruitful application of pneumothorax for diagnostic purposes. The movement of the lung in closed pneumothorax corresponds to the type for the normal lung, so long as there is negative pressure in the pleural space. In the perilous open pneumothorax the occurrence of paradoxical breathing, flapping of the mediastinum, etc., are easily recognized by roentgenoscopy. Especially impressive are the roentgen findings in pneumothorax with positive pressure. Characteristic of valvular pneumothorax as consequences of the increased pres sure are changes affecting the mediastinum and the diaphragm. Epidiaphragmatic, apical and mediastinal empyema, difficult of diagnosis, were first recognized with certainty by roentgen examination. Basal empyemas are differentiated from subphrenic abscesses by their border being concave toward the apex of the lung, while the border of the subphrenic abscess is convex. Also clinically obscure febrile cases are diagnosed by the roentgen examination which reveals a small empyema. The principal cause of a residual empyema cavity, namely, small bronchial fistulae, can often be recognized roentgenologically. In abscesses, stereoscopy is indispensable. If fever persists after operative treatment of abscesses and gangrene, clinical examination fails because of the depreciation of the significance of auscultatory and percussion phenomena from induration and scar-formation and bronchial fistulae. Here only the roentgen examination is of further aid. As operative procedure in the cavernous forms of bronchiectasis, pneumotomy is recommended; in the diffuse forms, pneumectomy; for phrenicotomy and thoracoplasty have brought but little improvement in bronchiectasis. On the other hand, thoracoplasty is recommended in unilateral cirrhotic tuberculous processes in the lung. The roentgen plate is of great significance in respect to indications for operation and determination of its extent; and it shows in the cases selected for operation, how the tuberculosis will heal; it shows the displacement of the diaphragm upward, and that of the mediastinum toward the diseased side. The rigidity of the thoracic cage hinders the healing process, which was first made possible by thoracoplasty. The roentgenologic studies of these occurrences have given the stimulus to an operative treatment of these secondary scolioses. The surgical treatment of pulmonary tuberculosis has been proved out upon 500 cases; the results were demonstrated upon plates and upon patients. In the discussion upon operative treatment of lung tumors, attention was called to the relative frequency of primary pulmonary carcinoma superimposed upon healing tuberculosis and bronchiectases demonstrated by the roentgenogram. Of 5 cases of primary lung tumor operated upon, one patient was living after five years and another after three. The difficult and not always risk-free procedure of esophagoscopy can in many cases be replaced by examination of the esophagus with a contrast meal. The roentgen examination often demonstrates tumors of the posterior mediastinum which give no clinical manifestations.

[1] Translated from a manuscript received through courtesy of Dr. Haenisch.

In the second paper, Küpferle of Freiburg gave an anatomical analysis of the roentgen picture in phthisis. With Graeff of Freiburg he has made roentgenologic-anatomic studies, by the use of a process of hardening the whole thorax and then making any desired number of frontal sections. This allowed topographic studies of the shadows appearing on the plate and of the phthisic foci lying at various depths in the lungs. The essayist demonstrated numerous instructive roentgen plates and the corresponding serial sections of the anatomic preparations, and showed how the often complicated shadows on the plates can be reduced to their individual components. The productive focus (granulation tissue) involves the acinus and shows on the plate fairly sharp, round to trifoliate flecks: the picture of productive-acinous-nodose phthisis. The exudative focus, on the other hand, quickly involves the lobule and on the plate has irregular borders. The third form, the indurative-cirrhotic tuberculosis, and the fourth form, the miliary tuberculosis, were clarified by the comparison of plates and serial sections.

Chaoul of Munich called attention, during the discussion of indications for thoracoplasty in pulmonary tuberculosis on the ground of roentgen findings, to the fact that the result of thoracoplastic operations is at times limited by the lack of resistance on the part of the mediastinum, so that the cavity cannot be collapsed.

Relative to the differential diagnosis of pulmonary tuberculosis, Fleischner of Vienna spoke of clinical pictures of hematogenous origin which simulate acute miliary tuberculosis, but which from their more favorable course bear a resemblance to ordinary chronic phthisis, in which the assumption that the inoculation of the blood-stream almost always leads to this fatally ending condition does not apply. These are the so-called secondary or early forms. The recognition of these forms is possible by the roentgenograms, and their differentiation from the plates of the tertiary stage is important.

Altschul of Prague discussed the roentgenologic and clinical aspects of primary tuberculosis. The primary complex of Ghon, occasioned by aerogenic infection, occurs in children and adults. Old as well as fresh primary foci are demonstrable by roentgenoscopy and roentgenography. Lymph-node changes depending on the location of the primary foci are, in many cases, to be traced as far as the paratracheal nodes. Altschul shows the different sites of the primary affection in the lungs, which may lie in the infraclavicular region and leave the apices free; oftener one finds several primary foci, even infiltrations and cavities. The clinical course of such cases was for the most part malign.

Peltason of Würzburg employs for the compression of the pulmonary apices for fluoroscopy and filming a spoon of soft wood, fashioned to fit the supraclavicular fossa, and with its border inlaid with a fine wire. Confusion of pathologic apical shadows with shadows of the soft parts, struma, etc., can thus be avoided. The plates of apices demonstrated showed perceptible increased illumination of the compressed field. Reimann of Berlin obtains the same result in another way, namely with Frick's instrument, a sort of forceps that presses upon the clavicular origins of the sternocleido muscles.

Kaeding of Bonn has observed anomalies of calcification in the anterior portion of the ribs in cases of pulmonary tuberculosis, and compares the unilateral decalcification with Sudeck's atrophy. In the discussion the suspicion was raised that this was an artefact due to the technique.

In the discussion on the theme of pulmonary tuberculosis, Romberg of Munich emphasized the value of the analytic anatomic diagnosis; he contradicted the opinion often heard, that the pulmonary processes are too complex to allow such differentiations. The classification into exudative and proliferative or productive and cirrhotic forms is to be preserved, with separation of the hematogenous disseminated exudative and disseminated proliferative forms. The differential diagnosis of pulmonary tuberculosis is absolutely necessary for surgical intervention and for roentgen radiation, as well as for tuberculin treatment. He emphasized the value of making plates of the apices and warns not to diagnose tuberculosis where there is nothing more than stasis or bronchopneumonia.

Haudeck of Vienna noted the often unfavorable prognosis of cases limited to one lobe; and von Dehn of Petrograd spoke of the difficulty of differential diagnosis between exudative tuberculosis, grippe and pneumonia.

The roentgenologic aspect of the dissemination of pneumokoniosis of miners has been studied by Böhme of Bochum. He shows that in the first decade of work in the mines no changes appear in the lungs; in the second, only exceptionally; but in the third decade they were found in 40 per cent of the cases. Most of them were light forms. The development of the disease seems also to depend upon the kind of coal and mineral mined.

Saupe of Dresden has made systematic investigations of the pulmonary disease of miners in Schneeberg in Erzgebirge, where for

several centuries has been recognized the "miners' disease of the Erzbergers," which in 1879 was designated pulmonary cancer. Bismuth, arsenic and cobalt are mined there. The principal symptoms of the disease are dyspnea and bronchitis. The roentgenologic findings in particular are disseminated small opacities, stellate and honeycombed. Pneumokoniosis doubtless prepares the ground for carcinoma, for of 143 miners examined, 4 had tuberculosis, 17 had pneumokoniosis (the differentiation from tuberculosis was often difficult), and in 7 there was tumor or suspicion of tumor (twice a carcinoma of a lobe and five times an isolated tumor the size of a fist). Four autopsies confirmed the diagnosis of carcinoma. A definite form of carcinoma characteristic for the Schneeberg cases was not found. Thus there is a prevalence of pulmonary carcinoma in a definite occupational group, which is perhaps predisposed to by pneumokoniosis, while tuberculosis plays a slight rôle. Investigations upon the etiology are in progress.

Lorey of Hamburg exhibited roentgenograms of pulmonary tumors. Most of them were of primary carcinoma. They are not as rare as was formerly believed and are often recognizable to the practiced eye. The solid tumor-like growths are the most frequent, and consist almost always of epithelium from the main bronchi; accordingly they begin with the picture of a hilus tumor. In their further course they infiltrate one or more lobes and can cause difficulty in differentiation from tuberculosis and aneurism. Lymphangitic carcinosis is rare: the thickened hilus region fades out peripherally in smaller and smaller flecks. The third form, miliary carcinosis, Lorey has seen once; it is not to be distinguished from the picture of acute miliary tuberculosis.

Lange of Munich showed roentgen plates of tuberculous disease of the vertebrae, with intrathoracic burrowing abscesses unmarked by significant clinical findings.

Kraft of Vienna showed a unique case in which the roentgenogram suggested echinococcus or tumor of the lung, but which on autopsy showed only a small pulmonary embolus, so that the plate was to be explained only by an infarct following embolism.

Flaskamp of Erlangen has observed striped thick-walled shadowy structures in the lungs of women who have been treated frequently with roentgen rays for mammary carcinoma; he regards the cause as former disease of the lungs. Haudeck of Vienna has seen the like; but he regards it as an indication of carcinoma tissue that the radiation has repressed.

Especial interest was aroused by the cinematographic pictures of the heart, by Grödel of Frankfurt-on-Main. Ten to sixteen exposures per second were made; a cardiogram synchronous with the film checked the analysis of the separate phases of action.

Hermann of Subotica spoke on unilateral hilus pulsation. In many people, even when the heart is sound, fluoroscopy with a contracted diaphragm shows a left-sided hilus pulsation. This phenomenon is very often demonstrable, especially easy to see when the lymph-nodes are shrunken or calcified. The nodes and the hilus structures then show a movement synchronous with that of the heart, principally horizontal, seldom obliquely upward. The patients have either slight complaints or none. The pulsation appears principally to the left, but is often present to the right. It is of significance that an anorganic systolic murmur is demonstrable, synchronous with the roentgenologically demonstrated hilus pulsation. Hermann believes that there is a genetic relation between the two, which, however, is to be worked out only by extensive pathologic-anatomic, roentgenologic and clinical investigations.

The communications on diseases of the stomach began with a roentgenologic and anatomic contribution to the knowledge of gastroptosis, by von Dehn of Petrograd, who observed that motor manifestations of irritability of the ptosed stomach often disappear on manual reposition. He attributes the manifestation to vagus irritation by dragging. Since he has been able to demonstrate plentiful smooth muscle fibers in the suspensory bands of the stomach, he regards the bands as capable of active contraction. Atony of the muscular elements in the suspensory bands can lead to a functional gastroptosis, which can lead to vagus disturbances.

Levy-Dorn has observed paradoxical gastric and intestinal function. He found the most diverse forms in one patient at four examinations at long intervals: at one time marked ptosis with ulcer symptoms, then the caudal pole at the level of the iliac crests and step-like indentations of the corpus ventriculi; several weeks later, marked cascade stomach with four-hour retention. On section, no pathology of the stomach was found, but there were old typhoid scars in the ileum. The condition, as had already been diagnosed, was a reflex neurosis. Careful interpretation of the roentgen findings is especially necessary in sick and frail people, for the organs are unduly susceptible to external influences. In such a patient the stomach was nearly full after four hours; a pyloric stenosis was diagnosed, which section failed to confirm.

Rieder of Munich discussed the anatomic

and roentgenologic differentiation between jejunum and ileum. The jejunal loops run more horizontally and show great numbers of Kerkring's folds; the ideal loops run more vertically, and show filling of adjacent loops, and a band-like form of the loops. Rieder demonstrated a small sterilizable cassette, with which he is able to identify a loop of intestine delivered through an operative wound.[1]

Dessecker of Frankfurt-on-Main reported an epidiaphragmatic diverticulum the size of a small apple, 40 cm. from the teeth. The operation is dangerous, but without operation the prognosis is absolute.

In the discussion Haudeck of Vienna spoke critically on the diagnosis of ptosis, and warned against confusing spastic hour-glass with typical ptosis shadows. In order not to lead the clinician away from other diagnoses, he does not make a diagnosis of atony on roentgen findings. Schreiber is of the opinion that clinical and roentgenologic findings can speak for ulcer, when the condition is only spastic gastroptosis. The complaint is readily explained by raising the stomach in front of the screen; when the stomach is raised, the pain disappears. Weinstein of Berlin described a frequent anomaly of the descending part of the duodenum: course bent over to the right. Adhesions have been shown to be the cause.

Köhler of Wiesbaden exhibited plates showing calcification of the radial and ulnar arteries of a nine-months-old child with Mongolism.

The roentgen diagnosis of the gall-bladder was discussed with lively interest. Teschendorf of Königsberg recommends the inflation of the duodenum through the duodenal sound introduced through the nose, until the patient feels distended; simultaneously administering a thick suspension of barium. Ulcer must be excluded beforehand. The inflation of the transverse colon with air he found of no aid, as in only a certain number of cases does it lie at the border of the liver.

Haenisch of Hamburg, encouraged by the American literature, has renewed his efforts on the roentgen diagnosis of gall-stones and the pathological gall-bladder. The technique is very exact and requires the making of many exposures, as well as experience and training of the eye. The procedure deserves further adoption, for when it is rightly employed it shows results worthy of notice. The demonstration of the pathologic gall-bladder is especially to be sought. Exposures with and without inflation of the colon give direct indications, examination with the Rieder meal give indirect. Instructive prints were shown, with unmistakable enlarged gall-bladder shadows, in which in some cases cholesterin gall-stones were indicated by spots of decreased density, and were later confirmed by operation.

Eisler of Vienna spoke upon the finding of transitory filling of the cap, which he regards as significant for the recognition of gall-bladder adhesions and changes in the duodenal wall.

Martius of Bonn described a simple method of measuring the pelvis. The patient is seated upon the table, with the upper body bent backward, so that the plane of the pelvic inlet lies parallel to the plate. The tube is centered over the middle of the pelvic inlet 60 cm. from the plate. The magnification varies with the distance of the symphysis from the plate; this is between 10 and 14 cm. The magnification is easily determined by a fenestrated rule (Drüner). One obtains not only the true conjugate, but also a true picture of the pelvic inlet. The method can be used with any sufficiently powerful machine without requiring expensive accessories; it is applicable even at the end of pregnancy.

Grashey of Münich demonstrated as an unusual roentgen finding a marked calcification of the Achilles tendon. He also reported a case in which a duck bone had been swallowed; the bone cast no shadow on a thorax plate. At autopsy the bone was found. It was rayed and cast only a faint shadow. This experience has made him cautious in drawing conclusions from negative findings in cases of suspected foreign body.

The luxation of the whole half of the pelvis in a ten-year-old girl who had been run over and dragged by an automobile was demonstrated by Levy-Dorn of Berlin. Haenisch of Hamburg mentioned a similar case which went for three months without diagnosis and was regarded as hysteria.

Levy-Dorn has demonstrated trichinosis *in situ* in the muscle of living patients. In a case which was confirmed by microscopic examination, there was slight granulation of the shadow of the muscle of the upper arm.

Seyerlein of Würzburg has studied the traumatic epiphyseal separations and their sequelae. The end-results of these not so uncommon fractures may be: (1) recovery (2) shortening of the whole member (3) partial disturbance of growth: in bilateral injury, shortening of the one and bowing of the other; in unilateral injury, angulation of the joint, when the separation involves only a part of the epiphyseal

[1] A less roundabout method of identifying portions of the intestine has long been available to American surgeons through the work of G. H. Monks of Boston, who has shown that the mesentery of the upper jejunum is translucent and contains a more simple system of blood-vessels supplying the gut; while in the lower ileum the mesentery is opaque from an increased amount of fat, and the vascular system is more complicated, the arteries breaking up into secondary and even tertiary loops before they reach the gut-wall. (See Monks' "Intestinal Localization," *J. Am. M. Assn.*, 1909, lii, 1079; also *Ann. Surg.*, Oct., 1903, and Oct., 1905.)

line (4) deformity of the joint of the hip, e. g., coxa vara, coxa valga (5) arthritis deformans (6) ankylosis.

Vogt of Tübingen demonstrated numerous roentgen plates of malformations (the examination has the great advantage that the specimen is not destroyed): Thoracopagus, prosthoracopagus, cephalothoracopagus, chondrodystrophy, acephalus, acephalus with inclusion, micromelia, malformations of the extremities.

Lorey of Hamburg showed a case illustrating the disappearance of the niche shadow. A walnut-sized convexity was found on the lesser curvature; but after eight weeks of ulcer diet the niche had disappeared. Thus it could not have been a penetrating ulcer with walls thickened by connective tissue. The ulcer must have penetrated the mucous membrane and the mucosa, so that the intragastric pressure bulged out the serosa. These pulsion-niches, in contradistinction to the penetrating niches, are healable. The contour of the pulsion-niche, unlike that of the penetrating niche, is quite smooth; also, it has no gas-bubble. Haudek of Vienna believes that in such cases apparent healing occurs; according to his experience the niche returns when the spasm returns. Lorey had in addition a case of periarthritis coxae, analogous to the periarthritis humero-scapularis described by Haenisch, with bean-sized calcification above the neck of the femur. A further case of Lorey's was of congenital syphilis in a child eight months old with a negative Wassermann; the plate showed luetic periostitis ossificans involving both femora and humeri. Antisyphilitic treatment was begun and during this treatment a control plate showed, two months later, typical osteochondritis luica on the distal ends of the forearm and the leg. Furthermore Lorey has observed spontaneous healing of osteitis tuberculosa multiplex in a child, and that without treatment and under not exactly favorable hygienic conditions. Lorey questions, therefore, the significance of such therapeutic measures as tuberculin, etc.

On the second day of the Congress, roentgen therapy was discussed. De la Camp of Freiburg opened with a communication on roentgen therapy of phthisis. He holds that the therapy of pulmonary tuberculosis is furthered:

1. By recognition of the diverse forms of its origin.
2. By knowledge of immuno-biological matters.
3. By constitutional considerations.

Clinical experience and animal experimentation show that healing depends upon the natural resistance of the body; roentgen therapy must keep this in view. Since breaking down of the lung tissue is dangerous and leads to cavity formation, radiation is suitable only for non-progressive cases, or cases of nodose phthisis with contraction of the lung, which incline toward latency. With these limitations, roentgen therapy is not superfluous; in no other way, except by immuno-biological measures, can a dosable energy be applied to the disease focus. As regards dosage, M. Fraenkel's dictum is to be kept in mind, that a pathologic cell-complex has its own modus of reaction. An attempt to designate a uniform dose is to be warned against. Each case must have a mild, stimulating dose, not a destructive dose. When one has dosed too heavily, the temperature goes up and the weight goes down. The results of application of a roentgen dose to the spleen are little understood, since we know not a thing about the function of the normal spleen. Therefore our knowledge of the results of radiation of the spleen is based upon hypothesis and empiricism. The bearing of this is that in radiation of the lungs, we also radiate the spleen and the blood. Radiation of the spleen in case of phthisic hemoptysis is usually contraindicated because of difficulty in transportation of the patient and the brief duration of the effect. Small cavities are no contraindication; but roentgen therapy after artificial pneumothorax is contraindicated because it may bring about an exudative pleuritis. Also, the employment of roentgen therapy together with tuberculin is generally contraindicated because of the simultaneous effects. Yet this holds promise for the future, in analogy with the synergistic action of drugs. As for technique, a symmetrical generalized radiation is sought. The essayist gives five fields anteriorly and five posteriorly, each 10 × 10 to 15 cm., with a skin-focus distance of 30 cm. and a filter of 1 mm. of copper. The dose is $\frac{1}{10}$ of a single skin dose, or 10 to 14 "e" by Friedrich's scale; increasing to a maximum of $\frac{1}{5}$ of a single skin dose; 1 to 2 fields a week. If this disturbs the well-being of the patient, the dose is reduced and the intervals lengthened. The series may be repeated in two to three months. Radiation of ambulant cases is strongly advised against, but the delegates were invited to contribute to this subject, for further foundation for the knowledge of the subject is much needed.

In the discussion, Bacmeister of St. Blasien showed numerous plates of chests before and after treatment by radiation, with marked effect in some cases. Even great cavities contract in a short time. Kästle of Munich observed that cavities can often be surrounded by a circle of granulation tissue. Fever-free patients without cavities and with not too

extensive, productive lesions can be submitted to ambulant radiant treatment, in his opinion. Bucky of Berlin has radiated the exudative forms in children, with beautiful results; and children without tuberculosis but suffering from severe general asthenia, were made considerably better by the treatment. Hessmann of Berlin has had similar good results with children; he uses ⅕ to ⅓ of the single skin dose, at a skin-focus distance of 35 cm., filtering through 8 to 10 mm. of aluminum. Caspari of Frankfurt-on-Main has had interesting results from experiments on mice. The radiated mice lived longer, but had more extensive tuberculosis than the controls. In closing, de la Camp warned again against radiating the exudative forms even in children.

Great interest was roused by the contribution of Holzknecht of Vienna, on "How do the roentgen rays produce their effect?" and the discussion which followed. Holzknecht stated that our knowledge of the working of the roentgen rays is slight at most, but that a comprehension of the associated effects is necessary, in order not to be led again along false ways: as for example, the teachings as to carcinoma and sarcoma dosage, which are false. The uniformity of effect, which most remedies show, is due to a uniform mechanism and will lead to a uniform explanation of the roentgen effect. The intensive deep therapy gives the impression of an overestimated idea. One finds individualization everywhere in the pharmacopeia; shall the mere amount of the remedy explain only roentgen therapy? When one understands the subject of paralyzing doses and stimulating doses, one recognizes, since he is radiating normal and pathologic tissue, that he produces four different effects. The Arndt-Schulz law[1] cannot be considered to apply to roentgen therapy. Holzknecht departs from the idea of the stimulant effect of radiation; the supposed stimulant effect is explained on other grounds.

Pordes of Vienna sought to answer experimentally the question: Is the conception of a functional- or growth-stimulation necessary for explanation of the effect of the roentgen ray? He comes to the conclusion that the growth-stimulus of radiated plant seeds is only an apparent one, for later there is a retardation of development of the radiated plants. The radiation effect hitherto known as the stimulation effect is now understandable as a simple depression of function. Experimentally produced growth-stimulus thus represents damage; the Arndt-Schulz law is not applicable generally.

Mühlmann of Stettin furnished a clinical contribution on stimulant roentgen radiation. In severe secondary and pernicious anemias, radiation of the bone-marrow had a good effect in the greater part of the cases; the result shows in eight to ten days. In 3 cases treated clinically without result, roentgen radiation produced improvement; 18 per cent of the erythema dose was given. Good results followed mild radiation in nephritis with anuria; also in a case of nephrosis, diuresis appeared several hours after radiation.

Zweifel of Munich regards radiation of the spleen as indicated when medical treatment does not relieve uterine hemorrhages, on a chlorotic basis; in 40 per cent of his cases he obtained benefit.

Czepa of Vienna, speaking for Schwarz of Vienna, reported on a distinction that apparently follows a law, between benign and malignant growth in respect to its behavior toward roentgen rays. Benign tissue, for example, the hair papillae, responds to the same degree to equal or diminishing doses; but malignant tissue decreases in sensitivity to the ray, and becomes roentgen-fast; thus recidive tumors develop from less marked residual tumors. Czepa has radiated the fingernails in an attempt to get a stimulant effect, and in 13 cases has gotten the most diverse results, and regards this method as unsuitable for demonstration of the stimulant effect. In the further discussion, Vogt of Tübingen reported no dependable results in the constitutional hemorrhages of young girls nor in inoperable carcinoma, from radiation of the spleen. Opitz of Freiburg believes that the stimulant effect has not yet been observed in radiation of carcinoma; the stimulant-radiation of the ovaries produced the desired results in only a small proportion of cases; the problem, he believes, is very complicated. Holfelder of Frankfurt-on-Main recommended that all clinical and experimental observations be registered and that meanwhile, the expression "stimulation" (Reiz) be dispensed with. Haudeck of Vienna concurs that the Arndt-Schulz law does not apply to cellular processes. Wintz of Erlangen has observed that lighter doses diminish the sensitivity of sarcoma to radiation. The cases of stimulation must be collected; exact dosimetry is necessary for settling the subject. Christoph Müller of Munich explains the stimulant effect used as an argument

[1] An account of the Arndt-Schulz law is given (*München. med. Wchnschr.*, 1922, lxix, 920) by Prof. K. Süpfle, from which it appears that in 1883 Rudolf Gottfried Arndt, a psychiatrist of Griefswald, made the following statement in his "Lehrbuch der Psychiatrie": "Weak stimuli kindle vital processes, medium accelerate them, strong inhibit them, and very strong destroy them." In 1887 Hugo Schulz, a pharmacologist, also of Griefswald but apparently working independently of Arndt, published similar conclusions in his work "Zur Lehre von der Arzneiwirkung." In 1892 Arndt brought out a monograph entitled "Biologische Studien: I. Das Biologische Grundgesetz" in which Schulz's conclusions are incorporated.

against radiation, as due to damage to the already cachectic organism; Volhard of Halle, by the conception of an *indirect* growth-stimulus by injury to the surrounding cellular tissue. Voltz of Munich sees in the Arndt-Schulz law a very useful working hypothesis. Happel of Frankfurt-on-Main sees the roentgen effect as explained by Dessauer's "Punktwärme" theory. Von Seufert of Munich regards an insufficiency of the surrounding tissue as the cause of radiated carcinoma "running wild." Nürnberger of Hamburg found no evidence of actinodynamic change in the uterine mucous membrane of patients in whom the spleen had been radiated. In closing, Holzknecht emphasized that the physical and biologic aspects of the problem should not be divorced. The conception of a stimulant-effect has not been confirmed as a scientific fact.

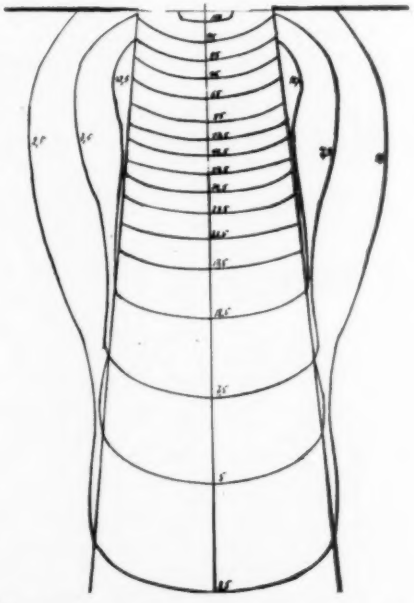
Theilhaber of Munich recommended, in his address on the electromagnetic waves and immunity, that multiple forms of this energy be combined (roentgen rays, diathermy, ultraviolet rays, etc.).

Strauss of Berlin has studied the influence of the roentgen rays on endocellular and metabolic processes. The literature on the effect of roentgen rays on cholesterin metabolism is wrong. The false conclusions result from a lack of method in experiment. He finds that the roentgen rays have a great effect on the cholesterin content of the blood. The "roentgen sickness" he regards as arising from the same cause. The radiation affects the hydrogen-ion concentration, as is demonstrable by the electrolytic method.

Sielmann of Munich spoke on roentgen therapy in Basedow's disease. Of 500 cases treated in the last ten years, he has followed up 328 within the last few weeks and found 50 per cent completely free from complaint and 44 per cent improved, while the surgical statistics show only 54 per cent of cases cured. The lesser danger speaks in favor of roentgen therapy, for the operation has 5 per cent mortality and can lead to paralysis of the recurrent laryngeal nerve and tetany. The essayist always radiates the thymus at the same time, and gives ⅓ to ½ of a single skin dose through 3 mm. of aluminum. It is of special significance that cases which were operated upon in vain were cured following radiation. Therefore one should first radiate, and operate only when radiation has failed. Pordes of Vienna recommends a mild radiation of a single field at first, to determine the tolerance.

According to Chaoul of Munich, lymphogranulomata in very cachectic patients are to be treated only with very mild radiation at frequent sittings, so as not to flood the system with catabolism products. Thus he gave a very sick patient 37 treatments, at each sitting only 10 per cent of the single skin dose. His 12 cases so treated have remained free from recidive for from seven months to three years. Nemenow of Petrograd added that the recidive of lymphogranuloma occurs usually in the peritoneal and retroperitoneal lymph-nodes and manifests itself at first only by temperature elevation and cachexia.

Haenisch of Hamburg presented a remarkable case of abnormally large lymphosarcoma, microscopically confirmed, which extended over the neck and chest, in which he began radiation with only two fields, single skin dose through .5 mm. of zinc and 3 mm. of aluminum, and in which, despite the complete regression of the tumors, there followed a severe cachexia. He does not recognize any standard dose for sarcoma or tuberculosis, and warns against beginning with intensive radiation, especially with mediastinal sarcoma, and advises strongly that a test radiation can be made on a few fields. Holzknecht recommends the most cautious dosage in Basedow's disease, lymphogranuloma, and leukemia.



Holfelder's curve of intensity of ray at varying depths.

Holfelder of Frankfurt-on-Main spoke upon the distribution of roentgen dosage in the depths of the body. He has experimented on the variation in intensity of the cone of the roentgen rays in a water-phantom. The experiments consisted (1) of direct observation and photometry of a zinc sulphite screen illuminated in water, and (2) of 50,000 measure-

ments by means of the roentgen dose meter of Siemens and Halske. The great agreement of all the results proves an almost complete separation of the scattered radiation from the direct. Especially astonishing and of practical significance is the fact that the intensity of radiation at the edges of the cone of rays falls off very suddenly to a negligible minimum. The cone of rays is sharply preserved even in great depths, and is surrounded by only a very faint and practically negligible mantle of scattered radiation. In this respect the results obtained stand in abrupt contradiction of the isodosage curves of Dessauer and Vierheller, according to whom the intensity of a cone of roentgen rays is diffused on all sides. That the form of Dessauer's isodosage curves does not agree with the facts and that his tables give false values, any roentgenologist can confirm by placing an intensifying screen in a water-phantom and observing the cone of rays. The sharpness of the cone gives the dependable foundation for the flexible dosage system which Holfelder has worked out with the principle of selective fields. In the discussion Voltz of Munich recommended controls of the measurements of Dessauer and of Holfelder, which presented such a great discrepancy. At the instance of the president, a commission on roentgen therapy and physics was appointed.

Küstner of Göttingen spoke on the question of dosimetry. The purpose of measurement is the attainment of a known biologic effect. Our different measuring devices, for example even the leaf electroscope, satisfy only in part the demand for a uniform standard of measurement. They react differently to the different wave-lengths (degrees of hardness) of the roentgen rays (for example, photographic plates and ionization chambers). Large and small ionization chambers are not equally affected by different wave-lengths. Of foremost interest today is the question: What is the sensitivity of tissues, sound and diseased, to roentgen rays of different wave-lengths? In addition, there is much interest attached to the measurement of the true energy of roentgen rays of different wave-lengths. The question is now: Is the latter problem of the greater practical importance, or can the first be solved without the aid of the second? The answer is of importance inasmuch as the measurement of the energy is attended by great difficulties. With a given intensity and a given filter, the mixture of rays from our roentgen tubes is practically constant. It can be analyzed spectroscopically and the component parts measured with the ionization chamber. We know by this means, what ionization each wave-length of the ray-mixture produces. We now separate from the ray-mixture a wave-length interval as narrowly limited as possible, practically homogeneous, and thus work practically with a single wave-length, and we study simultaneously its biological effect and its ionization effect, and follow the experiments through with various wave-lengths; but we use the same chamber in every case, and indeed the same with which we have measured the ionization in the spectroscopic apparatus. In this way we employ the ionization chamber to determine for each wave-length of the mixture of rays a biologic effect corresponding to its intensity. We then know: With a given intensity and a given filter the biologic effect is this, with another intensity and another filter it is that, etc. We can thus determine the biologic effect of the different intensities with a given filter and in this way we can find out which mixture of rays is the most favorable for a given case.

We thus see that we can dispense with the energy measurement, that with a suitably constructed ionization chamber we can attain the same end, if we only employ the same example for the spectroscopic measurement and the monochromatic biologic measurements. Küstner seeks the construction of an ionization chamber which is of constant sensitivity and yet is so cheap that every roentgen therapeutist can avail himself of it. Just as a standard meter is provided for measurement of length, so should a standard model be provided for measurement of the strength of roentgen rays. Then it will be possible for different roentgenologic institutes to employ the same dosage. It was decided to entrust the working-out of these problems to a commission.

Sielmann, Jr., has investigated the influence of roentgen rays upon metabolism, and its bearing upon the therapy of roentgen sickness. After being rayed, dogs excreted more NaCl than was fed them. Sielmann regards as the cause of roentgen sickness, a damage to the protein metabolism and disturbance of the NaCl equilibrium, and recommends infusions of NaCl, which he found beneficial in 85 per cent of cases. For convenient use in practice there is the ready-to-use preparation "roentgenosan." The possibility of the application of roentgen rays in cases of deficient salt-excretion and deficient diuresis was mentioned.

Holitsch of Pest modifies the gynecologic deep therapy in that he uses the tube under the table with the patient on her back. This smoothes out the skin of the radiated surface, and furthermore gives a compression from the body-weight, with an approach of the uterus toward the skin surface of an average of 2 cm. in comparison with the ventral position. He has

demonstrated the latter by comparative frontal exposures with a metal pessary in the uterus.

Winter of Munich spoke on his experience with the roentgen treatment of inoperable carcinoma of the uterus. He cites a number of apparently perfectly well women, who were radiated two to five years before because of inoperable carcinoma of the uterus. Of 197 cervical carcinomata, 50 per cent were recidive-free after one year, 24 per cent after three years, and 8 per cent after five years. He recommends that every carcinoma of the uterus that is not too far advanced should receive roentgen treatment.

Zweifel of Munich has had good results with the radiation of operable ovarian carcinomata three to four weeks after operation. By this combination he raised the percentage of cures to 50! Also in cases of residual carcinoma after operation in inoperable cases, radiation treatment offers hope of results. A case with incomplete operation remained well for eight years, with after-radiation with radium and roentgen rays.

At the end of the second day of the Congress a popular-scientific roentgen film was shown which was made at the instance of Doederlein in the Munich Frauenklinik under the scientific direction of Voltz. The animated film showed in impressive, instructive, and in parts amusing pictures, the revolution of the electrons in the Bohr model of the atom, the origin and the properties of roentgen rays, and the evolution of roentgen tubes and apparatus; in a second part will be shown the practical application of roentgen rays to various uses.

The third day of the Congress was devoted to technique and physics.

Glocker of Stuttgart opened with a paper on the application of roentgen rays to chemical analysis. The absorption bands resulting from placing a substance at the anticathode permit of qualitative analysis. A new application is quantitative determination of elements in chemical combination in solids and fluids, by measurement of the absorption-quality. Foreign substances in the mixture do not alter the result.

Stumpf of Munich has constructed a stereo-fluoroscope, using a diaphragm-box with two tubes which run simultaneously.[1] The rays are so diaphragmed that one tube illuminates only one-half of the screen, the second the other half, and the fields of rays decussate in only a small middle field. This construction is founded on the principle that one sees stereoscopically if one sees only a small part of an object binocularly. The apparatus allows exact depth-measurements.

Klingelfuss of Basel demonstrated a direct-reading spectrometer for roentgen rays. The hardness of the rays is read off in terms of wave-lengths. The sensitivity of the instrument is as great as that of a photometer for determining the shortest wave-lengths in a band-spectrum.

Schleussner of Frankfurt-on-Main has produced a new exposuremeter for roentgen exposures, the "Neo-Diskus," which takes into account the sensitivity of plates, double-coated films, roentgen paper, etc., and should be useful for beginners.

Chaoul of Munich exhibited a ray-condenser for small fields. It consists of a paraffin block 25 cm. × 25 cm. × 6 cm., with a central opening 6 × 8 cm. The intensity of the rays through the condenser was increased 40 per cent on the surface, 45 to 50 per cent in the depths. By radiating four fields, two anteriorly and two posteriorly, through 1 mm. of copper and at a distance of 30 cm., there can be delivered in the center of the abdomen 100 to 110 per cent of a single skin dose.

Heitz of Landau has substituted for the water-phantom a structure of paraffin-wax plates of the same absorption coefficient as water. It is more convenient to work with these plates than with a water-phantom. They are made of hard paraffin melting at 60°, with 20 per cent of wax added. Heitz also describes a practical method of insuring filtering, consisting in double hooks and also colored panes in the filter. The cable has a loop connecting with the hooks and cannot be connected with the tube except through the hooks.

Kraft of Dresden exhibited a photographic roentgen paper as a desirable substitute for films in the need of the time.

Cramer of Frankfurt-on-Main has had good results with sensitized "Neo-Papier" and recommends this paper above all for control exposures and for exposures of children.

Alfter and Gotthard of Munich spoke on spectrographic and iontoquantimetric measurements on roentgen apparatus. Kriser of Vienna has constructed an apparatus which by the use of an indicator which points out the central ray, allows radiation of the hypophysis with certainty. One may thus cover very small skin-fields; it is especially important, that one can easily radiate the hypophysis through infraorbital fields. He has also devised a lead capsule for the protection of one testicle while the other is being radiated. In the radiation of one ovary in fat women, to protect the other ovary from scattered rays he uses a lead vaginal septum which is pressed upon by a compressor in the midline above the symphysis.

[1] An attempt will be made to get a full description of this apparatus for a later number of the JOURNAL.

Beyerlein of Munich showed a new accessory apparatus for stereometric roentgenography.

Strauss of Vienna demonstrated the "Mekapion," a new measuring device for determining insulation and strength of rays. The working of this apparatus depends upon charging to a certain potential a condenser connected with the grid-circuit of an amplifying tube, which gives rise to periodical impulses of which the amplitude depends upon the amount of resistance parallel to the condenser. In this manner can be easily and exactly measured very high insulation resistances, and also the capacity and conductivity of fluids and gases and consequently the effect of ionizing rays.

Jaeger of Berlin has constructed a new roentgen dosimeter, which makes use of an ionization chamber and an amplifying tube. The dose is read off direct on the dial; at the end of the dose-period a bell rings.

At the end of the session Prof. Nemenow of Petrograd offered a resolution of fellowship in the name of the foreigners present from Holland, America, Bulgaria, China, Japan, Italy, Jugoslavia, Norway, Roumania, Switzerland, Russia, Spain, Turkey, Czekoslovakia and Hungary, expressing the pleasure felt over resumption of international scientific relations, and voicing the wish that German scientists may again be welcomed in other countries.

The president expressed gratitude for the spirit of the meeting and greeted the visitors in the name of the German Roentgen Ray Society, but observed that inasmuch as the international relations were suspended by those outside of Germany, resumption must naturally come from the same source.

Polak, John Osborn. Notes on the clinical value of radium in the management of uterine hemorrhage. *Med. Rec.*, Mar. 25, 1922, ci, 493.

The author gives a summary of the work done with radium in the clinic of the Long Island College Hospital. Its admitted use in cancer is granted. The author feels that it is only a matter of time when radium will replace operation.

In myopathic hemorrhages in young girls, sometimes obstinate to all forms of treatment, the endometrium becomes hypertrophied, and the uterus large and soft, the os tending to remain open. These cases were formerly treated surgically. Now the author applies radium in such a way as to establish a normal menstruation after one seance. Only once has he had occasion to repeat the exposure. In this class he treated 31 cases; the average dose was 400 mg. hours, and all but one of the cases received but one application. The last case, which required three applications, was followed by amenorrhoea for one year, after which normal menstruation was re-established. Six of these 31 girls are now married, and 2 have become pregnant.

Operation is still the procedure of choice for most myomata, for radium has certain disadvantages. Malignant complications may be easily overlooked, for it has been shown that sarcoma is found in serial section in about 9 per cent of submucous tumors. Fifty-four per cent of all fibroids are complicated with some form of tubo-ovarian disease. Radiation is not applicable in women who may yet bear children. Fibroids accompanied by pressure symptoms should be treated surgically. Irradiation will increase the necrosis of tumors which are already necrotic. On the other hand, should radium fail, operation is always possible. The menopausal symptoms are not so marked. There is no operative mortality and radium is the method of choice in myomata complicated by heart disease, extreme anemia, diabetes and chronic nephritis. When the tumors are larger than a four months' pregnancy the author prefers operation. One hundred and six cases have been treated by irradiation, the average dose being 2,000 to 3,000 mg. hours. Only 2 have needed subsequent operation. In both these there were large submucous tumors, the bleeding recurred, and at operation it was found that the tumors had undergone a marked edema. In the remaining 104 cases the bleeding ceased and has never recurred after the first menstruation. In 80 of these cases the growth has shrunken to less than half the original size. In 20 it has entirely disappeared.

Another class of cases which may be relieved by radium application are the bleedings resulting from subinvolution and fibrosis of the uterus without lateral or posterior parametritis or a history of pelvic inflammation. Two hundred and sixty cases were treated in this class. There were no failures to check the bleeding. Several in this class which were associated with prolapse have subsequently been operated upon.

Case, James T. Pericarditis calculosa (report of a new case discovered roentgenologically). *J. Am. M. Assn.*, Jan. 27, 1923, lxxx, 236.

The author reports a new case of calcification of the pericardium discovered roentgenologically. This makes the twelfth case thus far reported in the literature in which a diagnosis was made during life. These were all made by means of the *x*-rays (Schwarz 2, Groedel 1,

Rieder 2, Weil 1, Brauer 1, Assmann 1, Klason 2, and Mueller 1).

The author has reviewed the literature on the subject, giving the total number of cases found in the literature prior to 1922 as 90. It is significant that almost without exception the visceral and parietal layers of the pericardium are united by a plastic process, in which the calcareous deposit occurs. There is a total obliteration of the pericardial cavity. Impaired circulation is probably an important factor; other calcifying factors are decreased metabolism, necrobiosis and tissue necrosis. A number of the cases cited above give a history of pericarditis, pleurisy or some undermined "trouble" in the chest. It was only rarely, though, that a diagnosis of adherent pericardium was made during the life of the patient. The lime deposits occur especially over the anterior and inferior aspects of the ventricles, while the auricles are rarely affected.

The author thinks the process begins as a serofibrinous or fibrinous pericarditis. During the production of the reactive granulation tissue there is a reduction of the blood supply to the fibrinous masses, which, when not absorbed, may remain imprisoned for a long time. Such dead masses in which the circulation is very slow and insufficient have a decided tendency to undergo calcification (Klason). Naturally, the lime would accumulate in those regions of the pericardium subjected to the least disturbance from the contractions of the chambers of the heart.

The description of the calcareous deposits in a large number of cases was quoted verbatim from the literature.

From the roentgenologic standpoint the following may be suggested as signs of pericarditis adhesiva: (*a*) a triangular-shaped heart; (*b*) disappearance of the boundaries between the various heart chambers, usually made out fluoroscopically; (*c*) diminished excursion of the edge of the cardiac shadow during heart action, and (*d*) diminished mobility of the heart in relation to the diaphragm with the patient in the lateral positions.

The roentgenologic study of pericarditis calculosa should be carried out both with the screen and with plates. Several cases, finally discovered, went through repeated plate and screen study before the diagnosis was made.

Klason believes the fluoroscopic study more valuable than the roentgenographic. True, one can vary the penetration of the ray employed and can turn the patient in various directions more easily and economically with the screen than with the plate method. Case prefers a combination of screen and roentgenographic examination, though in the case reported in this paper he discovered the calcified pericardium while repeating a part of the barium meal study. Such a case impresses very forcibly the lesson that no fluoroscopic observation should ever be attempted until after the eyes have been thoroughly prepared for screen observations by a long preliminary stay in the dark.

Bishop, Louis Faugeres. Fluoroscope in the diagnosis of diseases of the heart. *Med. Rec.*, Mar. 25, 1922, ci, 489.

This is an article in which the author urges the value of the fluoroscopic examination of the heart, especially with reference to the fluoroscopic diagnosis of the activities of the different chambers of the heart and the probable auricular and valvular defects as well as the discovery of congenital lesions. The author ventures to assert that fluoroscopy will become a routine measure in every physician's office before very long. The author would rather forego the roentgenogram than the privilege of observing the heart in all its activities. He ventures to say that in the detection of minor impairments of the heart the fluoroscope is vastly superior to the stethoscope and when it is supplemented by the cardiograph at least 30 per cent of otherwise unknown conditions are added to the factors which must be considered. The mental process of discounting distortion of shadows due to the nearness of the tube in fluoroscopy is much easier than one would suppose. With reference to the normal heart the author believes there is really no such entity. The nearest approach can be found in a heart which is normal to the person carrying it. The heart of the laborer would be abnormal to a bookkeeper, for example. The one disappointing element in the subject of fluoroscopy of the heart is that the question of personal skill comes in and training of the observer is necessary. In cardiology nothing is more popular than the arithmetical formula, but so far it has usually failed to be useful.

Joseph. Death after pneumoperitoneum. *Berl. klin. Wchnschr.*, 1921, lviii, 1361.

Rautgenberg published his experiments with pneumoperitoneum for the first time in 1914. He and Goetze developed the method, and others have spoken very highly of its results. Mayer ascribes not only a diagnostic but a therapeutic value to it in the case of a patient with adhesions of the genital organs who had no further pain two weeks after the injection of air into the abdomen. He explained the fact by the assumption of a kind of massage ex-

erted by the air. Kaestle has made similar observations.

But, strange to say, one hears little concerning the use of pneumoperitoneum from surgeons. The fact is that this method is really unsurgical. Even if resulting lesions seldom occur, they are possible, and one shrinks from piercing the abdomen for purely diagnostic reasons. Another explanation is that there are unfortunate results to match the good ones.

Benthin publishes such observations. These are limited to the small pelvis, where the method seems most unsatisfactory. A tumor that could be palpated was not visible by roentgen radiation. Another seemed visible, but was actually non-existent. Leschke tells of intestinal injury in a case of carcinomatous peritonitis. Others mention various forms of discomfort to the patient.

Biernath found air in the abdomen at operation after twelve days. In a case of ulcus duodeni the whole parietal peritoneum and omentum were filled with air bubbles. Death followed from subphrenic abscess and lung infarct.

The technique has lately been changed and is now very simple, as it has been proved that ordinary air causes no more infection than do oxygen and nitrogen. Some use the usual pneumothorax apparatus, others a needle, with the air forced through a water-bulb. Goetze places the patient with the pelvis raised, a subatmospheric pressure zone then arises in the pelvis and the bowels follow the law of gravitation. He believes that injury can be avoided in this way.

Pneumoperitoneum has been used in a few cases at the Moabite hospital. Unfortunately one death occurred, and the report of the case is interesting, as the cause of death lay not in the method but in an anatomical abnormality.

A woman of forty had a movable tumor below the right ribs, the size of a fist. A kidney tumor was diagnosed, but for greater certainty a roentgen diagnosis with pneumoperitoneum was decided on. A needle was introduced into the abdomen below the navel, with local anesthesia, and air driven in at low pressure by means of a double bellows. The air-bulb contained about 150 c.c. When it had been emptied twice the patient suddenly collapsed, with cyanosis and rapidly diminishing pulse, and died in a few seconds in spite of every possible measure. Immediately on collapse the air and the needle were removed from the abdomen.

There was no trace of blood on the needle, or anywhere else at section, nor was any injury to a vein macroscopically visible. At the same time the autopsy showed that death had resulted from air-embolism.

A suspicious spot was found in the vena iliaca, where an injury was visible under the microscope, but this could not be definitely related to the puncture of the abdomen.

The patient had a strong scoliosis of the lower vertebral section to the right; the promontorium reached very far down and formed a strongly projecting elbow, so that it lay directly under the abdominal wall when completely relaxed, but could not be felt because of the considerable adiposity.

This anatomical abnormality is the only explanation of the accident.

The purpose of this report is not to discourage the use of pneumoperitoneum, but to call attention to the fact that such anatomical conditions require special watchfulness and precaution, and may even be a contraindication to pneumoperitoneum.

Bailey, Harold, and Bagg, Halsey J. Effects of Irradiation on Fetal development, *Am. J. Obst. & Gynec.*, May, 1923, v, 461.

The authors deprecate the many loose statements concerning the cure by irradiation of gynecologic conditions during all periods of sexual life with the intimation that no serious results follow the treatment of these conditions. They deem it proper to present some clinical and experimental facts relating to the subject, especially in regard to the reaction of the ovary and the developing fetus. The experimental data upon the lower animals have shown that when the sex glands are sufficiently irradiated before fertilization the following are typical fetal reactions:

1. Disturbed, abnormal, arrested development, resulting in the formation of monsters conforming more or less to a general type, and pronounced disturbances in the development of the central nervous system (Bohn, Perthes, O. and G. Hertwig, Schaper, Tur, Bordier and Baldwin).

2. A marked tendency to a progressive loss of fertility.

3. A specific modification of the hereditary mechanism (Mavor) and the production of inherited defects in the young, especially in the eyes (Little and Bagg).

Irradiation during pregnancy produces the following typical disturbances in fetal development, depending upon the developmental period at which the irradiation is instituted:

1. Disturbed, arrested, abnormal development with death of the embryos, absorption or abortion, stunting in growth, cataract, sterility, lesions of the central nervous system and blood vascular disturbances in the embryos. (Hippel and Pagenstecher, Regaud, Nogier, and Lacas-

sagne, Lengfellner, Krukenberg, Cohn, Walter, Bagg, Hansen, and Lacassagne and Coutard.)

In a discussion of the clinical reports it must be borne in mind that the data cannot be presented with the same scientific evaluation that may be given to experimental biologic studies, and although one realizes that one cannot directly transfer the experimental results from animal to man, yet apparently there is no reason for considering human developmental processes as essentially different from those of other mammals. It has been the aim of the authors to bring together the clinical reports, to interpret and correlate them as much as possible, and to add 6 cases. The authors recognize that developmental disturbances are to be found in many instances of human ontogeny where irradiation has never been applied and they wish to caution those who contemplate the irradiation of women during the child-bearing period with a view to preserving the procreative ability.

In judging the clinical reports the authors believe that in those instances where comparatively great disturbances have resulted in the child, the irradiation was given early in pregnancy. They believe that irradiation during early pregnancy may produce death and abortions of the fetus. Irradiation during late pregnancy is not so likely to produce gross developmental abnormalities in the child at birth, but the clinical data seem to agree with the experimental in several instances where children irradiated in utero at this period have been prematurely delivered, or have shown postnatal growth disturbances, or death within the first year. Werner reported 3 such retarded children, and 4 that died during the first year.

The severity of the treatment, as well as the period in development when the irradiation was given, no doubt determines the reaction of the fetal tissues. The authors' third case was treated during the fifth month of pregnancy, and then only locally, an effect largely due to beta-ray radiation within the vulval tumor. At the eighth month the mother was treated over the vulva with gamma-ray radiation which was equivalent to 50 per cent of the skin dose. The treatment was not severe, the fetus was not directly irradiated, and the child was apparently normal at birth and has remained so to the present time.

The second division of this study relates to the irradiation of women before conception where complete sterility is not produced. The experimental evidence in the lower animals shows with great probability that irradiation injures the follicular elements of the ovary. The authors' first case was suffering from Hodgkin's disease and ten months before conception was heavily radiated with *x*-rays. A male infant was born with an extensive developmental arrest in the formation of the head, and died after a few hours. The second patient was irradiated for a fibroid with gamma-ray radiation both from within the outside the uterus, and she became pregnant eighteen months later. In this instance a large, stillborn infant was born at term. The authors' last case was also irradiated with a gamma-ray radiation from a platinum tube placed in the uterus. Conception occurred seven months later, and the child was apparently normal at birth. The evidence is not sufficient to warrant our attributing the developmental defect in the first case, or the stillbirth in the second as due to irradiation.

The authors therefore conclude that it is questionable whether radium or *x*-ray irradiation should be used to destroy the ripe follicles, leaving the immature ones injured but capable of development. This statement is made entirely on the strength of the experimental work on the lower animals, and they do not feel justified in considering any of the available clinical records as adding conclusive evidence in this regard. In the treatment of menorrhagia in the child-bearing period they believe that complete sterility is preferable to the possibility of a damaged germ plasm.

Irradiation of the ovum during early pregnancy should never be permitted. Radiation in late pregnancy, while it may not produce gross abnormalities at birth, may hinder the growth and development of the child in later life.

GRANGER, AMEDÉE. A new technique for the positive identification of the sphenoid sinus and the ethmoid cells. *J. Radiol.*, Apr. 1, 1923, iv, 105.

Without taking the space to review the previous work done in this field, the author reports his own experiments, which are fully illustrated in the article. The reproductions surely support his claim for adequate identification of the sphenoid sinus and the ethmoid cells. The success was due mainly to the use of a head-rest which he had previously designed. This head-rest consists of a sheet of bakelite, with a triangular hole cut for the nose, attached to a wooden frame ½ in. high and about ¾ in. wide, the whole surrounded by a strip of wood ¼ in. thick and ¼ in. deep. By these means the bakelite sheet upon which the head will rest can be securely held over a film holder or cassette, and at the same time kept a distance of ½ in. away. When the nose is placed in the hole cut out in the bakelite sheet—the size and position of this hole having

been carefully determined—the head is automatically centered on the same part of the film, the soft tissues of the nose can be compressed without pain or discomfort, and what is much more important, the head now rests on the superior maxilla and the glabella. Two constant fixed points, varying little in heads of different sizes and shapes, now afford good firm support to the head, doing away entirely with the tendency to pivot either in the direction of its longitudinal or transverse diameter, a tendency always present when the nose is one of the two points on which the head rests.

The article needs reading to appreciate the numerous detailed points made by the author.

G. Gaertner. Death after pneumoperitoneum. *Berl. klin. Wchnschr.*, 1921, lviii, 1467.

(Remarks on an article by the same title by Dr. Joseph in No. 46 of this weekly.)

Some years ago the suggestion was made of filling the joints with oxygen for the purpose of roentgen transillumination. A surgeon simplified this method by using air. It succeeded a few times, then a patient died of air embolism. The author was reminded of this case on hearing of the plan of filling the peritoneal cavity with air in order to render its contents distinct before the roentgen rays.

The author proved in 1902 that large quantities of oxygen can be introduced into the veins of men and animals—several liters in men—without harming the organism. The gas is easily absorbed by the red corpuscles and never causes an embolism if the strength of the stream is not too great. This is not true of air, which causes certain death. On the author's suggestion the intravenous injection of oxygen has been successfully used to relieve sufferers from asphyxiation.

Since gas can enter the veins from a closed body cavity, only pure oxygen free from nitrogen or hydrogen should be used for the purpose: —never air.

An exception exists in the case of filling the pneumothorax with nitrogen. Perhaps the gases cannot penetrate the veins located there, because of pathological changes. Air, or still better, nitrogen should be used, as oxygen is too quickly absorbed.

The speed of the stream of oxygen must not be greater than the gas-absorbing capacity of the venous blood, or a fatal tamponade of the right side of the heart will result.

In using oxygen for pneumoperitoneum the injection should be slow and the heart continually ausculated. When the gas bubbles reach the left ventricle they make a loud splashing sound synchronized with the pulse. They do not indicate actual danger, but serve as a warning. The injection should cease, and some gas perhaps be drawn out again.

With the use of air or vapor the splashing sound indicates the greatest danger and immediate steps must be taken, not only precautionary ones, but the radical measures generally used in the case of air-embolism.

R. Rhule. Roentgenological studies concerning an alteration in the upper wall of the os innominatum known as the os acetabuli. *Arch. f. Orthop. etc.*, 1921, xix, 518.

The author has gathered together roentgenological material, together with clinical and autopsy reports, to prove that the small independent bony formation often seen in roentgenograms of the hip-joint, against the pubis and just above the head of the femur, is not the anatomical os acetabuli, and is miscalled when so designated by roentgenologists. He sums up his conclusions as follows:

1. The roentgenological os acetabulum is not identical with the anatomical os acetabulum, which is a constant pubic element.

2. The roentgenological os acetabulum is always to be considered as a pathological formation.

3. The roentgenological os acetabulum is usually the result of a rachitic, late rachitic, or osteomalacic disease of the bones.

4. In very unusual cases the roentgenological os acetabulum may be related to adults to a traumatic fracture, or it may be a tuberculous or osteomyelitic sequestrum of the upper acetabular margin, or a perior para-articular ossification, or a localized corpus mobile or a new bone formation.

5. In the case of late rachitis or its secondary diseases, the roentgenological os acetabulum is to be considered as a spontaneous infraction of a kind that causes mostly a general lightening of the bone shadow, or as a spontaneous fracture at a typical spot. The zone of illumination between the lateral bony segment and the pubis is probably a zone of transformation in Looser's sense, caused by a change of lamellar bone into uncalcareous, reticulous bone.

6. There is ground for the hypothesis that an upper acetabular margin extended into a spur as a result of rachitic alterations below the articular cartilage of the acetabulum (Fromme) plays a certain rôle in the formation of the roentgenological os acetabulum.

7. A knowledge of the roentgenological os acetabulum and of the possibilities as to its origin is of basic importance in accident surgery.

ENFIELD, CHARLES D. The scope of the roentgenologist's report. *J. Am. M. Assn.*, Apr. 7, 1923, lxxx, 999.

The author states that the ideal roentgen-ray report should present a careful and accurate description of the picture seen. It should offer whatever explanation of variations from the normal may be conservatively given on a basis of established roentgen pathology. It should give, when this can be conservatively done, an estimate of the activity and present importance of the lesion, such estimate, however, to be derived entirely from the roentgen signs. It should place in the hands of the clinician all the information the roentgenologist has been able to obtain by his peculiar method of examination and should offer it in such form as will most facilitate the correlation of the roentgen and clinical evidence.

In the course of his remarks, the author refers to some controversial points, particularly regarding the present attitude of the roentgenological fraternity toward roentgen-ray diagnosis of gall-bladder conditions. About gall-stone shadows there can, of course, be no question. If seen, they indicate with certainty the presence of gall-stones and, by inference, past or present gall-bladder disease. There are, however, two other types of positive roentgen-ray evidence with regard to the gall-bladder which have assumed steadily increasing importance during the last few years. First in point of time is the so-called indirect evidence of gall-bladder infection consisting in deformities of the duodenum, alterations in tone of the pyloric portion of the stomach, and fixation or other abnormality in the hepatic flexure of the colon. These phenomena are, of course, caused either by adhesions, resulting from inflammatory processes in the gall-bladder and ducts, or by reflex nervous disturbances originating in the same locality, or by both causes acting together. In their typical form they give a picture that is characteristic and convincing to a large proportion of roentgen-ray men. More recently, the effort to demonstrate the gall-bladder itself on the roentgen-ray film has somewhat overshadowed these indirect signs.

The author, in common with certain roentgen-ray workers, is extremely dubious about accepting the fact of a gall-bladder shadow as proof of gall-bladder disease. The whole point is one which will require much more work and a much larger series of operative checks to clear it up to everyone's satisfaction. In the meantime, reports of gall-bladder examinations in which the gall-bladder (but no stones) is shown, should indicate clearly that such a finding, while indicative of gall-bladder disease with or without stones, latent or active, does not by any means imply that surgical interference is called for on that basis alone.

FAY, TEMPLE, and GRANT, FRANCIS C. Ventriculoscopy and intraventricular photography in internal hydrocephalus. *J. Am. M. Assn.*, Feb. 17, 1923, lxxx, 461.

The authors report some interesting observations relative to the appearance of the functioning ventricle in the living subject. An opening through the thinned cortex in the silent area of the brain was planned as being a far safer procedure than the more formidable midline approach between the hemispheres. Through this opening, a No. 12 operating cystoscope was inserted, affording a clear view of the ventricular walls.

The authors' conclusions are as follows: Intraventricular photography and ventriculoscopy are possible in the presence of dilated ventricles. Little or no reaction follows such procedure when properly conducted. The diagnostic value of direct inspection of the ventricular cavities may prove of considerable importance in determining the location and the extent of growth of subcortical lesions causing deformities of the ventricles. A satisfactory approach with regard to the area and extent of the opening desired may be made through a dilated ventricle in order to permit callosal puncture under direct observation. Photography for the purpose of reproducing the appearance of structures or lesions within the ventricles requires at least forty seconds' exposure.

In view of the interest created in ventriculoscopy by the work of Dandy and others, this paper is extremely interesting.